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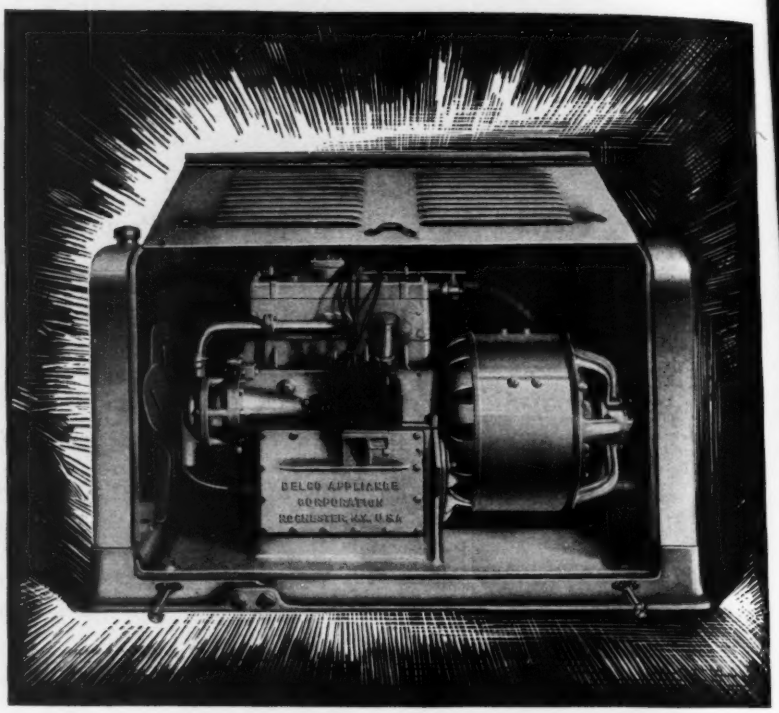

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Engineering News-Record

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Newark Solves Complex Transit Problem

Old Morris Canal through Newark, N. J., transformed into rapid-transit railway with surface and tube railway connections to New York City and a boulevard over the 1½-mile subway section in the business district

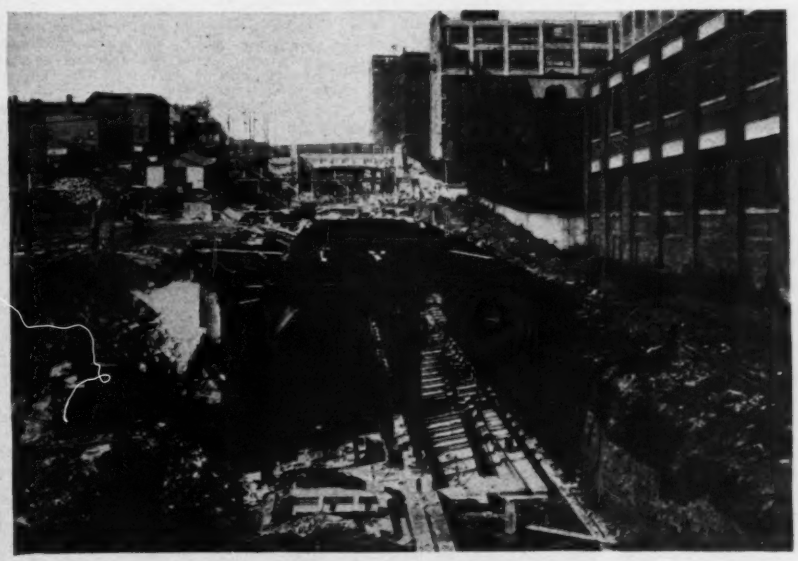
By Daniel J. Hauer

Civil Engineer, Long Island City, N. Y.

WITH a population of 450,000 and a large independent financial, commercial and industrial development, Newark, N. J., has the singular characteristic of being a state metropolis and a subcenter of New York in the great metropolitan area surrounding that city. Its city area of 23 square miles is hemmed in on the north and west by the rich residential towns of Bloomfield, Irvington and the Oranges, on the south by the city of Elizabeth and on the east, across the Passaic River, by the industrial centers of Harrison, Rutherford and Kearney, with Jersey City and Hoboken separated only by the Hackensack meadows. With a population density of 30 people to the acre, Newark has a heavy intra-city traffic, a dense commuter traffic to New York, a large shopping and commuter traffic to the residential towns north and west and a large through-traffic between New York and the New Jersey coast resorts and Philadelphia.

A careful count showed 750,000 passengers handled each week day within the city. In a year the trolley cars carried 164,286,777 and the buses 112,886,801. In eighteen hours 43,792 vehicles passed the busy crossing of Market and Broad Sts.

Fig. 1—Subway structure of Newark City Railway built in the bed of the old Morris Canal. Bridge in background carries street over a new 52½-ft. paved boulevard that tops the subway.



Comprehensive planning to improve these congested traffic conditions was inaugurated in the middle twenties by the creation of the North Jersey Transit Commission. With Newark as a center, lines were projected connecting the city with Paterson, Hackensack, points in Bergen, Passaic, Essex and Union counties, and these towns with each other and with the boroughs of Manhattan and Richmond in New York City. These plans resulted in nothing productive. Today, therefore, the transit lines continue as then to be the bus and trolley lines radiating from Newark, the six steam railways to New York City and the passenger line of the Hudson & Manhattan Railroad surface and tunnel route to Manhattan.

The original studies and the interest created by them did, however, center attention on transit relief. The public service company operating the streetcar system in Newark and 142 other New Jersey municipalities and

buses in 243 towns and cities sought relief for its lines. After this the Pennsylvania Railroad sought to obtain local relief in Newark and to do away with the Manhattan transfer. Meanwhile the city of Newark had purchased the section of the old Morris Canal lying within its limits and furnishing a possible right-of-way, traversing the city from north to south. Use of this right-of-way for transit relief was a natural thought.

General plan

With sentiment for transit relief in agreement, the planning problem was to provide for, first, local passenger travel, including suburban travel; second, commuter travel to New York by the Hudson & Manhattan tubes and the steam railways; and, third, through-vehicle traffic.

The plan worked out comprised a railway, part underground and part depressed, in the bed of the old canal; a new terminal for the Pennsylvania Railroad and its subsidiary, the Hudson & Manhattan Railroad; and a system of street widenings and new streets. On Jan. 9, 1929, the city contracted with the Pennsylvania Railroad to build the railway to be know as the City Railway (Fig. 2). On its part, the Pennsylvania agreed to build a new terminal over the south loop of the City Railway; to bring the Hudson & Manhattan to this terminal and extend it to South St., thus giving it two stations in Newark besides the present station at Park Place; to provide beneath the Pennsylvania tracks a bus terminal at the north end and a taxicab stand at the south end of the new station. At the same time a contract was made with the public service company to operate the City Railway, furnishing cars, power and maintenance, and to pay the city $125,000 a year rent and 5 per cent of the gross passenger receipts.

A street improvement plan was coordinated with the terminal and railway plans. It has long been desired to widen Academy St., in order to relieve traffic northbound on Market St. (Fig. 2). It was planned to do this and then to build a new street (Raymond Boulevard) over the subway portion of the City Railway. The new street, it was expected, would relieve Academy St. of all but the heavy slow-moving traffic. The widening of Academy St. by 24 ft. is required only to Wickliffe St., beyond which it is full width. The new Raymond Boulevard, with overhead bridges for High, Summit and Colden Sts., permits high speed from Plane St. to Warren St., and, ending at New St., turns west and takes some of the heavy East Orange traffic from Central Ave. Lock St., a continuation of the boulevard, is to be widened 30 ft. to Sussex Ave. and on to Orange St., again taking some traffic to the Oranges from Central Ave.

High St., running parallel to Broad St., has 70 per cent as much traffic as Broad St. An overhead bridge (Fig. 1) over the boulevard, with Academy St. (on the left) widened, will ease some traffic of High St., but the building of bridges at Summit and Colden Sts., together with the cutting down of a hill on Summit St., about 14 ft. from Warren to Market Sts., and the widening of Silk St., from Academy to Market Sts., will take much traffic from High St. Another diversion will be by Wickliffe St. to Market St. to South Orange Ave. and Springfield Ave.

Fig. 2—Underground and depressed railway in bed of old Morris Canal is main artery of transit-relief plan for Newark, N. J.

Mention has been made of the congestion of vehicle traffic at Broad and Market Sts. The state highway department has cooperated with the city to divert the through-traffic by building a highway known as route 10, passing near the Passaic River and carrying traffic to northern New Jersey, and route 25 over the meadows by way of the Newark airport to New York. There is also the Holland Tunnel route going by the city to Elizabeth and south.

Railway design

The City Railway as planned is subway from Union Station to New St., 1½ miles. From New St. to the city line at Belleville the railway is depressed between retaining walls or in fenced-in open cut. All the crossing streets except Orange St. pass over the railway. Fig. 2 shows the relation of the railway to the Hudson & Manhattan and the Public Service terminals and the Pennsylvania station, the construction of which is not a part of this article.

For construction the railway was divided into seven sections, the two loops being sections 1 and 7. The total length was 4½ miles. The first contracts, for sections 4 and 5, were let in the fall of 1929. Except for crossing bridges and isolated structures of other kinds, the major construction and design problems were on the subway section. From New St. to the city line the work was shallow open cut fairly indicated by the cuts flanking the bridge (Fig. 3).

A typical cross-section of the subway and surmounting boulevard structure is shown by Fig. 5. The design of the subway structure proper is in general that which has become standard in New

Fig. 3—Section of depressed railway, showing bridge of crossing street, precast concrete-cribwork retaining wall and right-of-way fencing.

York City. As in New York, knee-braces are not used at the tops of the columns. The bents are on 5-ft. centers. The center columns have welded base and cap plates, and the side columns have riveted clip angles. Unlike present practice in New York and like that in Philadelphia subway work, the duct bank is outside the structure, with manholes opening to the street or the tops of retaining walls. It is expected at first to operate trolley cars, but stations and other details are designed for trains.

Construction methods

Construction generally followed familiar subway practice for open cut. Covering of the cut was required only where crossing streets had to be carried, and here the usual structures of planking and beams on staging or piling were employed. In the loop construction at the Pennsylvania terminal and in the approach subways, one under the other, to the Public Service terminal, there was deep trenching, which called for heavy sheeting and bracing and rather extensive well-point unwatering equipment. Ordinarily the cutting called for little bracing and no unusual procedure. Power shovels handled the excavation, both earth and blasted rock, but hand labor was used extensively on sections 3 from Washington to New Sts. and on section 6 approaching the Bellville terminal loop. This unemployment relief measure gave work to some five or six thousand men and proved to be not unduly expensive.

Fig. 6—Section of subway under construction, showing concreting plant, with tower and chutes, mounted on crawler tractions.

In general, the underpinning work was light; about twenty buildings required some support. The methods were unusual only in one case, where precast concrete blocks were used, and in another, where the system shown by Fig. 4 was employed on about a dozen buildings. The buildings generally were carried on wall and interior columns footed on earth a few feet above rock. Fig. 4 indicates the conditions for an eight-story building.

The first operation was to trench between wall-column footings and to build a concrete wall between columns down to the bottoms of the column footings. This acted as a retaining wall to prevent any movement of the earth under the floor and around the interior columns. The second operation was to continue this wall in a series of alternate operations down to rock surface and then to build piers under the columns to solid rock. In all there were 27 operations, as indicated by Fig. 4.

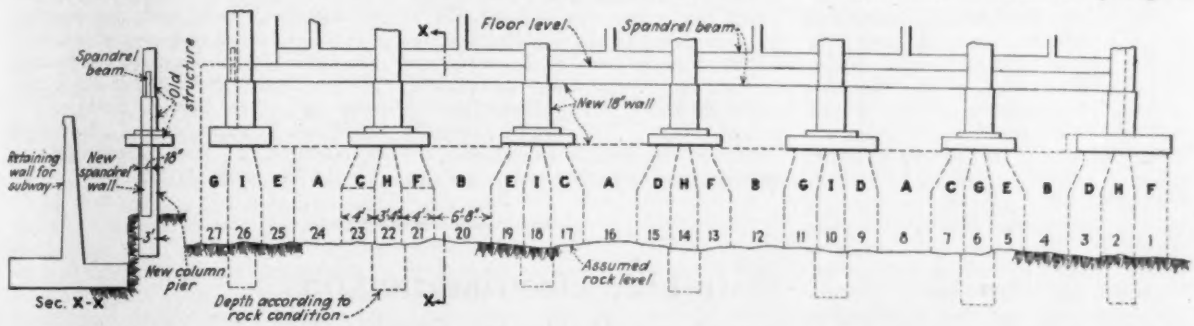

Spandrel beam
Old structure
X
Floor level
Spandrel beam
New 18" wall
Retaining wall for subway
New spandrel wall
18"
3'
G I E A C H F B E I C A D H F B G I D A C G E B D H F
4' 3' 4' 6'-8"
27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
New column pier
Assumed rock level
Depth according to rock condition
Sec. X-X
X

Fig. 4 (above)—Diagram of procedure followed in underpinning buildings on shallow footings above rock.

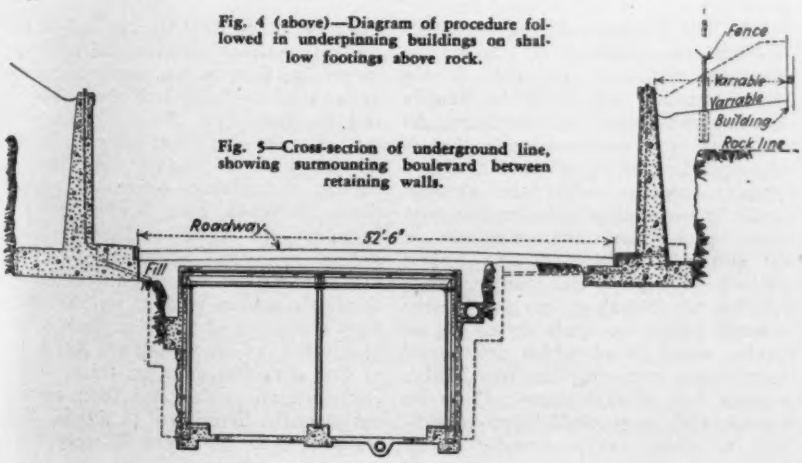


Fig. 5—Cross-section of underground line, showing surmounting boulevard between retaining walls.

These were carried out in groups as lettered. The three *A* sections were built first, followed by the three *B* sections; it will be observed that these six sections of wall took a bearing under every footing but one. The construction of the *C* group, *D* group and other groups followed in order, and use of a high-early-strength cement made the concreting almost continuous. The method was developed by the contractor, the Thomas Crimmins Co., New York City.

The concrete work for the structure was ordinary in type, but particular effort was made to control its quality by exacting tests and inspection. These adhered closely to the practices urged by the technical associations. Tests began at the sources of the raw materials and continued throughout their

Fig. 7 — Undercrossing at Central Ave. (Fig. 2), showing turnout ramps connecting with surface lines.

proportioning and combination into concrete to the final determination of the strength of the concrete in the structure. Incidentally the crushing strengths of concrete ranged for 7 days from 2,000 to 3,220 lb., for 14 days from 2,200 to 4,200 lb., and for 28 days from 2,900 to 4,600 lb.; the averages were respectively 2,530, 3,158 and 3,555 lb.

One of the more notable features of the specifications was payment for cement on the basis of volume of concrete, as determined by the formula: Volume of concrete = (Sum of unit weights of each material) ÷ (Apparent specific gravity × unit weight of 1 cu.ft. water).

Roughly, the concrete proportions were 1 part cement and 4½ to 6 parts aggregate. Preference was given to mixing on the job; ready-mixed concrete is allowed only where there is real reason for its use, and then inspection is rigid, beginning at the plant.

The job-mixing plant exhibited only one novelty in the mobile outfit shown by Fig. 6, which also indicates the concrete finish. The mixer and tower were mounted on crawlers, and the concrete was chuted directly into the forms from subway subgrade. Most of the plants operated from the tops of the banks. The tower plant shown by Fig. 6 was developed by the Clifford F. McAvoy Co., Newark, the contractors for sections 4 and 5.

Special structures

Not including the bridges, the special structures on the railway are few. The bridge construction is indicated in type and appearance by Figs. 1 and 3. The last structure is interesting as showing a type of bank support used in open cut where the banks ran high to meet bridge or street levels and wash was to be feared. The cribwork of concrete is precast in face members and members that extend back into the bank and are held by the earth. With a precast coping, these retaining cribs had a neat appearance, were easily constructed and gave excellent drainage while holding the bank firmly.

A steel bridge of some importance carries the City Railway over the tracks of the D.L.&W. Railway. Originally a subway crossing under the Lackawanna tracks was contemplated, but its cost led to a temporary plan of bringing the City Railway to the surface at Orange St. and then over the D.L.&W. tracks on a steel bridge flanked by approach ramps. When traffic reaches a volume to warrant the expenditure, the subway crossing will be built. Another special arrangement, this time under an existing steel bridge, was called for at Central Ave. Fig. 7 indicates the arrangement, which provides ramps for a turnout connection with the surface lines.

Underground services affecting the railway work have been limited to crossing streets and generally have not been too complex to handle by simple supports and familiar bypassing methods. At Plane St., however, a 7½-ft. brick sewer called for a siphon under the subway; and as there were 10- and 36-in. water mains, also a 6-in. gas main and two duct banks to be cared for, it was decided to build a pipe gallery as a part of the siphon structure. This structure was of noteworthy size but involved no exceptional design or construction problems.

Direction

As an engineering undertaking the City Railway commands attention less for the structural and construction problems involved than for its part in the solution of a complex city-transit problem. Altogether the project described is noteworthy among city works to relieve traffic congestion and to hasten vehicle movement.

The work has been carried out under the direction of the Newark Department of Public Affairs, Jerome T. Cougleton, mayor. James W. Costello is chief engineer, Department of Public Affairs. Ralph Smillie is transit engineer, in charge of construction of the City Railway and bridges. Under him are Eberhard Welle, designing engineer, Chas. L. Crandall, engineer of construction, and Thomas Darrow, resident engineer. Martin Schreiber is chief engineer of the Public Service Coordinated Transport, and L. P. Struble is engineer of Newark improvements for the Pennsylvania Railroad.

Main-Line Electrification on Southern Railway, England

A 30-MILE stretch of main-line electrification, opened in July by the Southern Railway, England, is the first electrified section of the 52-mile line between London and Brighton. As Brighton is a residential city that is almost a London suburb and is also a popular seaside resort, the through traffic is very heavy including non-stop steam trains that make the run in 60 min. The electric trains consist entirely of multiple-unit sections, with a motor car in each six-car section; the express trains are made up of six or twelve cars, all of which are parlor cars. Each motor car has two 275-hp. motors. In general there will be an electric train every half hour, in addition to steam trains transfer being made at Three Bridges, the end of the present electrification. The entire 30-mile stretch has four tracks, partly composed of two separate double-track lines. Third-rail conductors of 100-lb. T-rails are used, with 660-volt direct current. Transmission lines of 33,000 volts deliver current to eighteen automatic substations. Automatic color-light signals are installed; the signal and interlocking system is very complicated because of the numerous junctions. A similar third-rail system is used on the company's network of suburban lines south of London, which aggregates 300 miles of line with 800 miles of track. This electrification project has been carried out under the direction of G. Ellson, chief engineer of the Southern Railway.

New Method of Proportioning Concrete for Road Work

Simple rational method of designing pavement mixtures employed in 1931 in concrete road construction in Arkansas

By W. W. Zass
Engineer of Construction, Arkansas Highway Commission, Little Rock, Ark.

A SIMPLE and rational method of determining the percentage of fine and coarse aggregate in relation to the total mineral aggregate to be used in a concrete paving mix may be expressed as a relation: unity minus the solid volume of coarse aggregate per unit volume of coarse aggregate equals the percentage by solid volume of fine aggregate to be used in the mix.

This relationship is understandable and simple to obtain, involving only the weight per unit volume of the aggregates and the apparent specific gravity, from which factors the apparent solid volume per unit volume of the aggregate may be obtained, or conversely the voids per unit volume. The relationship maintains for aggregates of any sizing, either of the poorly or better graded types, with the exception of fine aggregates, of which more than 5 per cent retained on the No. 4 sieve may require that such excess be equated as coarse aggregate. It also conforms to previous theories advanced as to the proper proportions of fine and coarse aggregates to be used in any stated mix, to the extent that such theories do not depend upon arbitrary factors in reconciling different series of gradings or sizings.

The preceding refers particularly to the fineness-modulus theory of determining the percentages of fine and coarse aggregate in relation to the total as well as to the surface-area theory, which provides an inverse ratio of values in comparison to the fineness-modulus theory. The Talbot and Richart theory is substantiated to the extent that when the fine-aggregate constant is determined upon for any given fine aggregate, an amount of coarse aggregate can be introduced into the mixture to the extent that the voids in the coarse aggregate introduced are equal in amount to the solid volume of fine aggregate specified, thus providing a rational method of determining the constant B over b_o, used in accordance with that method, by previous calculations rather than trial and experiment. It will be found that the expression B/b_o so obtained is in accord with the recommendations made by Talbot and Richart upon the basis of their research work in this field.

The practical exposition of the theory outlined has been confined to the design of paving mixes, some 150 miles of the Arkansas 1931 program having been designed upon this basis. The results were entirely satisfactory, the theory being equally adaptable to crushed stone or gravel coarse aggregates.

To illustrate the theory, the following examples are offered, one providing for a coarse aggregate of gravel and the other providing for a coarse aggregate of crushed stone, both being normal materials used extensively in their particular localities. The standard specification for Arkansas paving work provides for a minimum cement content of 5.4 sacks of cement per cubic yard of concrete and a maximum water content of 5.25 gal. per sack of cement. It should be noted particularly before proceeding further that the theory as outlined does not contemplate the determination of a cement content or a water ratio, but after the adoption of such factors it does provide for a simple method of determining the percentage of fine and coarse aggregate in relation to the total mineral aggregate to be used in the mix.

PHYSICAL CHARACTERISTICS OF MINERAL AGGREGATES

	Source	Fineness Modulus	Max. Size In.	Per Cent Retained No. 4	Apparent S.G. Heat Dried	Wgt. per Cu.Ft. Heat Dry and Rodded	Solid Volume per Cu.Ft.	Voids per Cu.Ft.
Crushed stone.....	Big Rock.....	8.02	2	..	2.67	99	0.593	0.407
Sand.....	Big Rock.....	2.63	..	3	2.63	110	0.669	0.331
Gravel.....	Crow Creek....	7.81	2	..	2.59	105	0.649	0.351
Sand.....	Crow Creek....	3.20	..	7	2.64	115	0.697	0.303
Cement.....	.....	....	..	..	3.10	94	0.485	0.515
Water.....	.....	....	..	..	....	....	1.000	0.000

On the basis of the minimum cement content and maximum water-cement ratio specified, the solid volume of cement and water per sack of cement would amount to $0.485 + 0.700 = 1.185$ cu.ft., and the yield of concrete per sack of cement would amount to $27.0 \div 5.4 = 5$ cu.ft. Therefore, the solid volume of mineral aggregates used per sack of cement would amount to $5 - 1.185 = 3.815$ cu.ft. Combining the Crow Creek sand and gravel in accordance with the relationship as expressed, the percentage of solid volume of the fine aggregate would amount to unity minus the solid volume of the coarse aggregate per unit volume, or 1. — 0.649, or 35.1 per cent. The per cent of coarse aggregate would be similar in amount to its solid volume per unit volume, or 64.9 per cent. Therefore, the solid volume of fine aggregate per sack of cement would amount to 35.1 per cent of 3.815, or 1.339 cu.ft., and the solid volume of coarse aggregate to 64.9 per cent of 3.815, or 2.476 cu.ft. In this instance B/b_o would amount to $0.495 \div 0.649 = 0.763$. The percentage of fine aggregate in accordance with the fineness-modulus theory, considering 6.2 as the maximum fineness modulus of the combination, would be equal to $\frac{7.81 - 6.20}{7.81 - 3.20}$, or 34.9 per cent, and the percentage of coarse aggregate would be 65.1 per cent.

The combination of a crushed-stone coarse aggregate and a medium-graded fine aggregate, such as the Big Rock materials shown, did not permit the use of the minimum cement content allowable but required a cement content of 5.8 sacks of cement per cubic yard of concrete if the maximum water-cement ratio was to obtain. On this basis the yield of concrete per sack of cement would amount to $27.0 \div 5.80 = 4.655$ cu.ft., and the solid volume of mineral aggregates used per sack of cement would amount to $4.655 - 1.185 = 3.470$ cu.ft. Combining the Big Rock stone and sand in accordance with the relationship as expressed, the percentage by solid volume of the fine aggregate would amount to 40.7 per cent and that of the coarse aggregate to 59.3 per cent. Therefore the solid volume of fine aggregate per sack of cement would amount to 1.1412 cu.ft., and the solid volume of coarse aggregate to 2.058 cu.ft. In this instance B/b_o would amount to $0.442 \div 0.593$, or 0.745. The percentage of fine aggregate in accordance with the fineness-modulus theory, considering $6.20 - 0.35 = 5.85$ as the maximum fineness modulus of the combination, would be equal to $\frac{8.02 - 5.85}{8.02 - 2.63}$, or 40.3 per cent, and the percentage of coarse aggregate would be equal to 59.7 per cent.

The foregoing are typical examples of paving mixes used during the 1931 period, and the similarity of the results obtained through the use of the fineness-modulus theory and the use of the relationship as now expressed are quite evident. It is also evident that the results of the equation B/b_o, as obtained through the relationship as expressed, are normal to the values cited by Talbot and Richart. Also, as previously noted, the Talbot and Richart theory can be further simplified by using the relationship as now expressed of fine and coarse aggregate to the total mineral aggregate when the proportions of fine aggregate have once been decided upon in accordance with that theory, rather than in endeavoring to obtain the volume of the coarse aggregate by trial methods.

Four-Sided-Frame Bents Carry 19-Story Tower

Large ground-floor banking room 60 ft. wide in Dayton building is spanned by girders and trusses with supporting columns carried on basement girders of same span resting on concrete mat under entire tower area

By Nelson J. Bell
Consulting Engineer, Dayton, Ohio

Fig. 1—Building of Mutual Home and Savings Association in Dayton, Ohio, in which ground-floor banking room 60x112 ft. in plan controlled the structural design.

THE STRUCTURAL design for the twenty-story office building recently completed for the Mutual Home and Savings Association in Dayton, Ohio, presented some unusual problems. The site is approximately rectangular, 80 ft. 4 in. wide and 199 ft. long. The foundations had to be placed on water-bearing gravel and sand which, with shallow strata of clay, extends to rock located at least 400 ft. below street level. The architectural design included a room 59 ft. 8 in. wide and 34 ft. high, centered between the side walls and extending unobstructed by columns from the front wall 111 ft. 5 in. toward the rear. Spaces for superstructure supports and for elevators, stairs, shafts and light courts were confined to strips 10 ft. 4 in. wide at the sides of the large room. A tower, 80 ft. square and nineteen stories high (Fig. 1), was placed over the front of this room, and six office stories were placed over the rear. Two basements under the entire building were designed to accommodate a parking garage and the mechanical equipment. It was desired that space be provided in the second story for some offices and for storage and employees' rooms, as well as for horizontal runs of piping, conduit, etc., and that all stories above the second should be rentable office space exclusively. A plan of the framing at the second-floor level is shown in Fig. 2.

General design

The principal structural problems to be solved were: (1) to carry the loads from twenty stories on a 62-ft. span; (2) to spread the loads from columns placed near the side walls over a sufficiently large bearing on gravel; (3) to brace the high slender supports against wind pressure.

The structure above the third floor presented no difficulties and was designed by the usual methods, the wind stresses being carried mostly by the wall bents.

Trusses and Girders — The usual method of bridging long spans in high buildings by means of trusses extending through two or more stories was not practicable because the elevators and stairs (Fig. 2) had to be placed next to the side wall, and trusses extending through the third story would have blocked the elevator lobby. The method adopted had to be confined to a height of 12 ft. in the second story, which, being used mostly for utility space, could be arranged to suit the structural requirements.

With these limitations it was found that trusses could be practically designed to carry the six stories in the portion back of the tower, but not to carry the tower portion because of the difficulty of making connections of web members to chords in the available space. Girders were therefore used for the five bents under the tower.

A corridor was necessary in the second story to provide access to the various rooms. Since the loading was almost symmetrical about the center of the span, a large proportion of the girder web could be omitted at this point, and the corridor was therefore located on the center line of the building. Openings in the web 8 ft. wide and 7½ ft. high, less kneebraces at the upper corners, were provided.

Foundations—To spread the column loads on the gravel soil under the tower, it was found that a continuous footing 30 ft. wide was necessary on each side of the building. This created an eccentricity of 6 ft. 4 in. in the footings and consequent excessive moments in the footings and columns. Steel foundation girders spanning the entire building width were therefore adopted, thus eliminating eccentricity in the footings and most of the flexural stresses in the columns. The tower bents thus became four-sided frames, symmetrically loaded on top and bottom, with a lateral wind load at the top. Fig. 3 is a diagram of bent *D*, the most heavily loaded bent but typical of all the tower bents in design. Under the seven-story portion isolated footings could be designed with little or no eccentricity, and foundation girders were not necessary.

The two 30-ft.-wide continuous footings under the tower would, if constructed, have covered all of the ground area except a 19½-ft. strip in the center, in which a thick waterproofing slab would have been necessary. A single reinforced-concrete foundation mat extending over the whole area under the tower was therefore adopted. This mat supported the exterior walls and wall columns in addition to the foundation girders, and formed a broad solid base on which to found the entire structure. It was 80 ft. 4 in. wide, 90 ft. 6 in. long and 3 ft. 6 in. thick, reinforced at top and bottom, with continuous bars in two directions.

The foundation girders were placed in a sub-basement and extended its full height. The upper basement was thus left reasonably clear of obstructions, and its use for a parking garage is quite satisfactory. These girders could have been constructed of reinforced concrete integrally with the foundation mat, but the spaces between them were required for mechanical equipment, so that steel was used, both because it occupied less space and because of the greater ease of attaching it to the columns. Bearings 30 ft. long were grouted at either end, the center 19½ ft. being left free.

Openings through the foundation girder webs at the center of the building were provided in much the same manner as in the second-story girders. Due to the method of loading, the center 14 ft. is practically free from shear, and the web was omitted entirely for that width.

Windbracing — The bracing of the columns was accomplished by connecting together the pairs of columns at the ends of bents with diagonal web members composed of pairs of angles, thus forming vertical Warren trusses extending from the lower to the upper girders. Four of the tower supporting bents were braced together at their ends with struts at each floor level from the basement to the third floor, and with X-bracing in all the panels thus formed, each panel bracing being composed of two pairs of angles. All the bracing connections were riveted, and the resulting structure was very stiff.

At the third-floor level the wind loads had to be transferred from one system of framing to another. The concrete floor slab was specially designed as a system of horizontal beams and cantilevers to accomplish this transfer, diagonal bars being used to carry the shears direct between panel points.

Design of a typical bent

The second-floor framing plan (Fig. 2) shows the designation and positions of the supporting columns and the principal members required to span the large first-story room. Girders on lines *C*, *D*, *E*, *F* and *G* are typical in design and, with the columns on line *B*, carry the tower. Trusses on lines *H* and *K* have the same span as the girders but carry much lighter loads. Trusses on line *M* and on lines 3, 4, 6 and 7 each carry a single concentrated load and are comparatively light.

In bent *D* (Fig. 3), which is typical of the other bents, the top girder can be assumed to be supported wholly on columns 2 and 8, with columns 1 and 9 acting as hangers supporting the dead weight of the side walls. The foundation girder can be assumed to receive no load from columns 1 and 9 but receives two large concentrated loads from columns 2 and 8, and two small ones from columns 4 and 6. The bearing loads are uniformly distributed over 30 ft. of length measured from each end. The wind load is assumed to be applied at the third-floor level and resisted at the basement-floor level.

With these assumptions, the following principal shears and moments were computed:

	Top Girder	Bottom Girder	Legs
End shear.....	2183 *K*	2614 *K*	39.6 *K*
Cantilever shear..	1335 *K*	1076 *K*	.....
Center shear.....	6 *K*	0	39.6 *K*
End moment.....	10400 *K'*	4660 *K'*	1920 *K'* and 0
Center moment...	24230 *K'*	22970 *K'*	960 *K'*
Wind shear.....	100 *K*	0	50 *K*
Wind moment....	1463 *K'*	1463 *K'*	1463 *K'*

The girders were designed by standard methods from the shear and moment diagrams based on the tabulation above. Tension connections for columns 1 and 9 were made to both girders, and the bearings of columns 2 and 8 on each girder were made with milled billets.

The ends of the foundation girder were embedded in the reinforced-concrete side walls, which were in turn tied to the foundation mat by heavy reinforcement. It was assumed that this condition would reduce the cantilever moment and increase the center moment. Accordingly the chord sections at the center were increased beyond the theoretical requirement.

The bent when assembled became a statically indeterminate frame of such proportions that a more exact method of stress analysis was deemed desirable. Accordingly a check design was made by the slope-deflection method developed by Prof. G. E. Large and published in *Proceedings*, Am.Soc.C.E., November, 1931, and this was checked by means of Prof. Hardy Cross's method of distributing fixed end moments (*Proceedings*, Am.Soc.C.E., May, 1930).

Administration—The building was designed by Schenck and Williams, architects, Dayton, Ohio, for whom the writer was chief engineer. The steelwork up to the third floor was fabricated by the American Bridge Co., and above the third floor by the Dayton Structural Steel Co. All steel was erected by the John G. Pool Co., Dayton, Ohio.

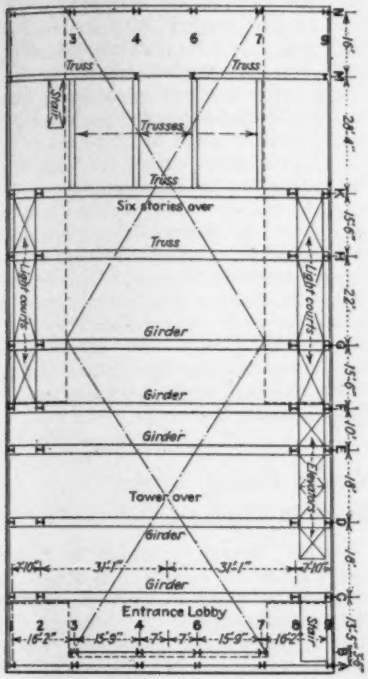


Fig. 2—Girders carrying tower and trusses carrying six stories at rear are confined to a 12-ft. height between second and third floors. This second-floor plan shows how the superstructure is carried by pairs of columns at either side of the building.

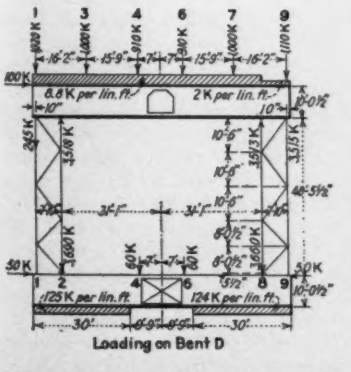


Fig. 3—Typical tower bent, shown with loading for bent *D*. The foundation girder was necessary to secure centric loading on the gravel foundation. Of the supporting columns, Nos. 2 and 8 support the top girder, while Nos. 1 and 9 act as hangers carrying the side walls.

Shorter Working Time to Assure Full Employment

Shorter working hours and higher living standards to compensate for increased efficiency of machine and man will keep the reservoir of unemployed labor low and assure balance of consumption and production

By D. C. Henny
Consulting Engineer, Portland, Ore.

THE SHORT working week, vital subject of present-day interest, is the key to industrial and economic stabilization in the author's opinion. He recognizes tacitly the large share of responsibility resting on engineers in connection with industrial stabilization, especially since their contribution to the steady increase in productive efficiency promotes the unbalance between production and employment. Most engineers question the average business man's fatalistic belief that depression is cyclical, like floods and droughts; they hold that business activity can be stabilized, but they do not agree on the method. Probably not all will agree with the author in thinking that economic breakdowns will be prevented if all workers can be kept at work. But they are bound to admit that such an improvement would advance human affairs remarkably. —EDITOR.

OF THIRTY MILLION manual workers in the United States, from eight to nine million are at present unwillingly idle, according to best estimates. About one-sixth of our total population is without dependable support. Here we stand before a phenomenon which, viewed from any side, has the most important implications and is a shameful blot on our much-boasted civilization. If starvation in China results from local shortages, ours results from abundance.

It is to the credit of our people that intolerable conditions have not led to more alarming results than the marching of a bonus army and rioting in scattered localities. But we cannot yet foretell what may be in store for next winter, when seasonal cessation of work may raise further the level of the unemployment reservoir that already threatens us. It must be apparent that whatever remedy is suggested for our social disease it should have the one unquestioned ef-

fect of holding this reservoir to a low and safe level, preferably of emptying it.

Unemployment Is Not Necessary—A surplus labor reservoir has existed for a long time. We have become used to it, and in the past the industrialists considered it a necessity. For them it is a convenient source from which to draw labor during times of sudden expansion of business. Our labor population, however, looks upon it with less favor, as it sharpens competition for work and tends to depress labor's standard of living. Industrialists themselves are now beginning to view it questioningly and to recognize labor as an important factor in consumption as well as in capital ownership. This important change is softening economic class distinctions to such an extent that today little argument is necessary to show the great benefit that would accrue to society as a whole if unemployment could be ended and if the large part of our population now dependent on charity in some form or on a demoralizing dole could be reemployed and recover its earning power, self-respect and social stability.

The present economic paralysis has its direct origin in fear, which is permeating all strata of our social body like poison. If the unemployed worker is most drastically affected, fear works its deadly harm from this stratum upward. Marginal millions are in daily fear of losing their jobs by replacement or by intensified business depression. Whatever past thrift has permitted them to lay aside has been cut into by reduction of values and by bank failures; what remains is being hoarded. Fear is likewise gripping the minds of the middle classes and of the professional men, of whom other thousands, not included in unemployment statistics, are also without work.

It might be concluded that the overflowing reservoir of unemployed labor is the principal cause of our ills. Such reasoning is sound only in so far as it leads to the conclusion that it is a prime necessity to empty this reservoir as quickly, effectively and permanently as possible. However, in order to find the way to accomplish this the question must first be answered as to what caused this reservoir to rise to the dangerous height we witness today.

Efficiency Causes Unemployment—The man in the street argues that it is the depression that caused factories to close, borrowing power to drop and the building of public works to cease. He may say further that periods of prosperity and depression come in natural sequence and hence are unavoidable, and that (as many times before) all we have to do is to wait until stocks on hand are depleted, after which manufacturing will begin again and lift us out of our present depressed state.

This argument is the more dangerous because it is in many respects sound and may cause us to fail to diagnose our case thoroughly and to sit idly by when quick action of some kind is urgent, not merely to save the employment situation but to save our capitalistic form of society and our political structure. The argument is incomplete because it overlooks the principal cause of unemployment.

Machinery, in replacing manual labor as it was intended to do, left society two ways to deal with the consequence. One was to lessen the hours of labor of all workers, the other to lessen the number of laborers. Society made the fatal error of choosing the latter alternative. It is true that about 45 years ago there was a reduction of the standard labor day from twelve to ten hours, and 25 years ago from ten to eight hours. These reductions, humanitarian in motive, fortuitously prevented serious economical dislocations. Outlets for surplus labor also were found which no longer exist, such as the settlement of the West. With the rapid progress of machine improvement, another step in the spread of labor was due several years ago, but its necessity was obscured by the immense destruction caused by the World War, by high-pressure salesmanship, installment buying and other devices to stimulate consumption temporarily.

It is this replacement of human labor by the machine going on night and day at ever-increasing rates that is superimposed as a persistent factor on the ups and downs of business activity. The effect of this replacement has been accumulating for many years, and failure to reduce working time in harmony with it is responsible for the greatest part of our present plight. This effect cannot be permanently balanced by efforts to increase production forcibly unless we enter at the same time on a new policy of spreading labor.

Reduce Working Time—The new policy should be to reduce hours of labor per man to the point where the surplus labor reservoir will be emptied and will be kept low at all times by balancing increased machine efficiency and increased man efficiency against reduced working time and rising standards of living. This would be the long-time policy, rather than a cure for present conditions.

Consumption has dropped to such a low level that if reduction of working time alone is to be depended on to relieve unemployment quickly, a temporary excessive reduction would be necessary, from which it would be difficult to retreat in future. It is at this point that artificial stimulation of production may step in to aid in fighting unemployment and to restore confidence. The relief bill is intended to perform this function. It has the further advantage that by its own terms it carries the gospel of spread labor into every state of the Union.

The shorter-working-time policy has been sporadically adopted in various parts of the country in an effort to keep working organizations together, and labor has at times preferred a general reduction to seeing part of its body laid off. These are encouraging signs, but their effect as regards the entire country is very small. Besides, competitive industry puts a penalty on the individual public-spirited manufacturer, who, while retaining all his force, must compete with his neighbor, who retains his best men only and works them long hours. This objection can be overcome only by a simultaneous reduction of working time on a national scale.

National Action May Be Required—It may be necessary to invoke the force not only of municipal and state law but of federal law as well. Fortunately public opinion, which appeared deaf to the plea for shorter working time, is now rapidly shaping itself in favor of such policy. It is gradually becoming clear that any manual laborer or mechanic who is asked or who consents to work longer hours for pay than the optimum time found to be necessary to keep all workers employed takes the bread from the mouth of another workman, to the detriment of labor and of society. Once the public's attention is focused on this fact, the movement for shorter working time will become nation-wide, and in this expectation can be found the first real sunshine breaking through the clouds. It will likewise become clear in time that greater leisure is for the good of the workman and of society as a whole.

Rubber Paving Blocks Tried in England

Paving blocks in which a rubber wearing surface is sealed to a base of concrete or other material have been laid experimentally in London and Bristol, England, by the Rubber Roadway Co., London. The blocks are laid on a concrete slab. In the Cowper design, however, three layers of rubber of different characteristics form the entire 2¼-in. thickness. These blocks, 9x4½ in., are tongued and grooved on all sides, so as to interlock and form a unit surface or paving. The Cresson block, 9x3 in. and 3 in. deep, has a base of "rubber concrete" composed of crushed stone, sand and liquid rubber compressed under high pressure and given a ⅜-in. thickness of rubber vulcanized to the top of the block. Vitrified brick forming the base of the Gaisman block has dovetailed recesses to anchor a layer of hard rubber, which is topped with ⅜ in. of softer resilient rubber. This block is 10½x8¾ in., with a total thickness of 4½ in. The North British block, 9x4½ in., is of very similar design, but its base is of concrete 2½ in. thick, with steel inserts to anchor a ¾-in. layer of hard rubber to which is vulcanized the ¾-in. wearing surface of more resilient rubber. For sidewalks and interior work there are blocks 9x4½ in., with a ½-in. rubber surface on a concrete base ½ in. thick.

200-Year-Old Masonry Dams in Use in Mexico

Built for early irrigation development, these ancient structures are notable for boldness of profile, disregard for spillway operation and the excellence of their hydraulic-lime masonry

By Julian Hinds
Chief Designing Engineer, The Metropolitan Water District of Southern California

FEW AMERICANS know that extensive irrigation works, including some large masonry dams, were under development in Mexico at a time when our Western plains were untouched prairie. A center of this early irrigation was in the state of Aguascalientes, about 300 miles north of Mexico City, and the region still contains many evidences of the developments, including dams now nearly two centuries old. The present President Calles project is being built in the same state and is affected, directly or indirectly, by the water from some twenty of these old dams. They are most interesting hydraulic structures, unique in appearance and in many cases notable for boldness of design. The principal features and some of the details of three of them immediately adjacent to the Calles project are described in the following.

Pabellon dam

The Pabellon dam (Figs. 1, 2, 3 and 4) seems to have been constructed originally for storage, power and diversion purposes. As nearly as can be ascertained, it was built about 200 years ago. That the height was at some time increased is indicated by a change in the style of masonry at a point several feet below the present crest. The average annual runoff of the Pabellon River is perhaps 40,000 acre-ft. Flow at the site is very flashy, being negligible a great part of the time. As the capacity of the reservoir is about 800 acre-ft., it has little effect upon floodflow, and storage is supplemented by two off-channel "tanks" constructed at the upper edge of the valley lands and supplied by a diversion canal from the dam. One of these tanks is still in use, and the other appears to be usable.

Power development consisted of a mill for grinding grain, but the equipment has long since disappeared, except the old millstones and the millhouse, which is in ruins. The tailrace from the mill discharged into a small canal leading to the ranch house and an orchard below. This canal, which is still in use, can also be supplied from an independent outlet in the dam or from a wasteway in the diversion canal.

The dam consists of a masonry wall 580 ft. long on the crest and 77 ft. high at maximum section, reinforced by buttresses on the downstream side. A spillway at one end of the dam (Fig. 1) consists of a number of openings closed by stoplogs. Apparently these stoplogs are never removed, floods being allowed to pour down over the rough surface of the dam. The crest is a few inches lower at the spillway end than in the center, so that small flows pass over that part of the dam, but at flood time the entire right half of the dam is a spillway.

This structure, as well as the others discussed, is constructed of rubble masonry known locally as "mamposteria." Some idea of the general appearance of the work can be gained from the pictures. None of the stones are cut, although they are sometimes roughly squared by the quarrying methods. The rock is generally rhyolitic

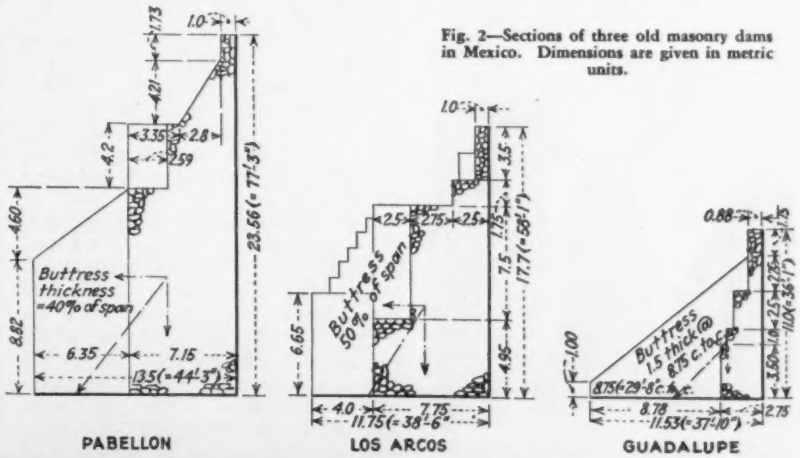


Fig. 2—Sections of three old masonry dams in Mexico. Dimensions are given in metric units.

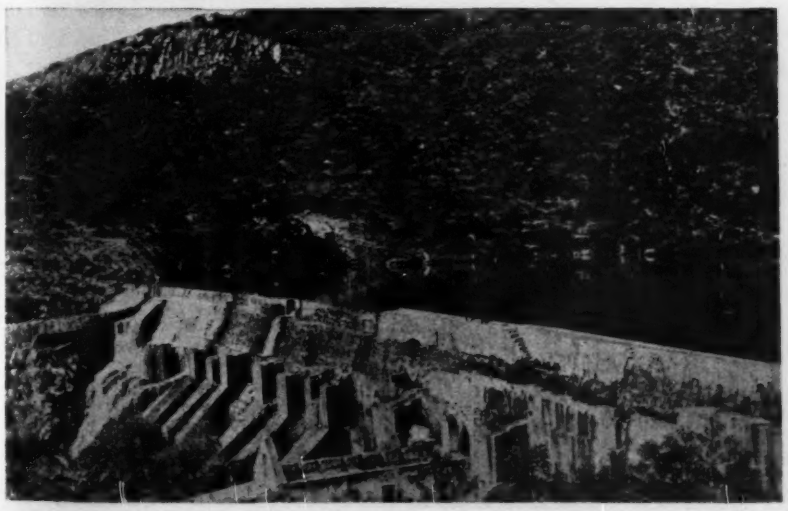


Fig. 1—Spillway stoplogs are not removed on the 200-year-old Pabellon masonry dam, and floods have overtopped the crest without causing damage.

in this particular region, and the mortar is said to have been made from locally produced hydraulic lime. It is generally found to be remarkably hard and sound at the present time. An excellent example of the durability of this mortar is found in the water-worn spillway section of the Pabellon dam, where 200 years of overflow has caused little damage.

A notable feature of this old masonry construction is the violation of the present-day requirement that the stones shall be laid upon their natural bedding planes. In certain parts of the structure the rocks are deliberately placed on end with broken joints. It is said the idea was to enable the masonry to resist tensile stresses; however, these vertical stones are used in many places where tension is impossible. An example of this type of construction is shown in

Fig. 4, which is a view of the downstream face of the Pabellon dam near the headworks of the diversion canal.

Unfortunately no data are available as to the details of the control gates for the diversion canal. They are homemade affairs operated by iron or steel bars that extend above the water surface. They are opened by prying the stem up with a bar and are closed by driving it down with a hammer or stone. Whatever controls originally existed for the mill gates and the supply for the small low-level canal have disappeared. The canal outlet is now closed by wooden plugs at the downstream face, some smaller parts of which can be removed and replaced under pressure.

A stress analysis of this dam is difficult to make because of the lack of uniformity of section. The resultant obtained from an approximate analysis at the buttress is shown in Fig. 2, left. The buttress, which has a thickness of about 40 per cent of the span, is assumed to act as a T with half of each of the adjoining body sections. The specific gravity of the masonry probably does not exceed 2.2, which corresponds roughly to a weight of 138 lb. per cu.ft.

Fig. 3—Buttresses represent 40 per cent of the span of the Pabellon dam, which is 77 ft. high.

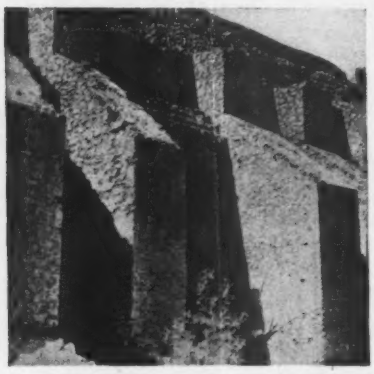


Fig. 4—Rocks placed on end are a notable feature of the masonry, the theory being that they help to resist tensile stresses.

The resultant, as shown on the section, falls outside of the kern, and the masonry at the upstream face is either in tension or is lifted from the base, tilting the load onto the downstream corner of the buttress.

The nature of the connection of the base of the dam to the foundation is unknown. However, there exists at the present time among the descendents of these old dam builders a practice of digging "pot holes" over the surface of the rock foundations of a structure of this kind into which may be cemented the ends of slender vertical rocks. These stones are called "dientes" (teeth) and are supposed to bond the dam to the bedrock. It is probable that the Pabellon dam was treated in this manner. The value of such treatment is uncertain.

The computed tension at the upstream face of the section shown is 4.5 tons per sq.ft. If this tensión is possible, the compression at the toe is 16 tons per sq.ft. These stresses do not allow for uplift. If tension in the masonry is impossible, still ignoring uplift, the section tilts over until the computed compression becomes about 21 tons per sq.ft. Any attempt to figure full uplift pressure over the base of the structure or

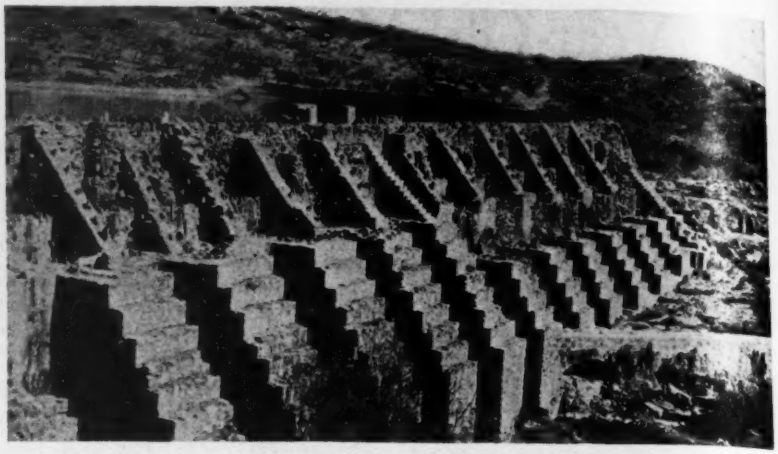


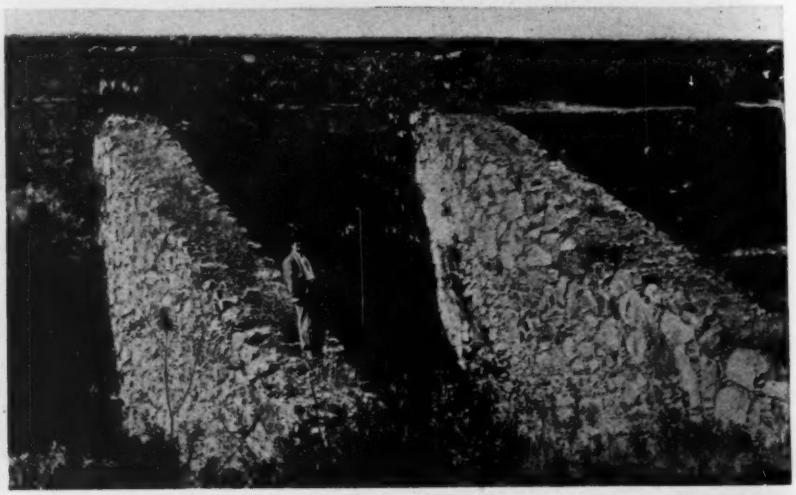
Fig. 5—Rock dowels were left in the top of the Arcos dam for bonding future extensions. Note that many of the buttresses were never completed.

even over the theoretically lifted upstream part of it rapidly increases the tilting. It seems likely that there must be little upward pressure under the structure. There is a bed of silt against the dam, probably deposited in part before the dam was raised to its present height. It is possible that this silt blanket may serve to seal off any cracks resulting from the present overstressed conditions. The original structure was probably free from theoretical tension. No allowance is made in the analysis for any possible increase in horizontal pressure due to silt. The sliding factor without uplift is 0.79.

Arcos dam

An equally interesting structure is the dam known as Presa de los Arcos, on the main stream of the Morcinique River, about 7 miles east of the city of Aguascalientes (Figs. 2 and 5). Its maximum height is about 65 ft., slightly less than the Pabellon dam, but it has a crest length of 720 ft. The section is

Fig. 6—Buttresses of the old Guadalupe dam directly support only 17 per cent of a thin masonry wall.



more nearly stable, as is shown by the pressure line in Fig. 2, center. The rocks protruding in the upper part of this structure (Fig. 5) were presumably intended to furnish bond in case of further enlargement. It is interesting to note that a number of the buttresses were never completed.

This dam was evidently strictly an irrigation enterprise, as the customary millhouse ruins are lacking. Irrigation water is withdrawn by means of a small masonry aqueduct, which crosses the river about a half mile below the dam on a stone-arch structure having an appearance of antiquity that does full justice to its probable life of 150 to 200 years. It is from this structure that the name Los Arcos is derived. This conduit is in use at the present time. The spillway consists of three small stoplog gaps at the right end of the dam. The logs are never removed, floods being allowed to overflow the dam. Details of the outlet gates are not available.

Guadalupe dam

A striking example of boldness in design is found in the San Jose de Guadalupe dam (Figs. 2 and 6), also on the Morcinique River. The body of this dam is so thin and the slender buttresses are so widely spaced as to simulate a buttress wall with a reinforced face. However, the entire construction is of rubble masonry laid in hydraulic-lime mortar. The structure is theoretically stable against overturning and, on the simple theory of overturning, is not subject to vertical tensile stresses at the upstream face, if the possibility of uplift is ignored (Fig. 2, right). There must, of course, be horizontal tension in the face slab. The sliding factor is 0.98.

This dam was constructed in two stages, the original crest having been just below the bank of vertical rocks at the top of the buttresses (Fig. 6). Although the date of first construction is not known, the upper part was built in 1865, as is attested by a tablet on its face.

The river section of this dam is of substantial proportions and is provided with a stoplog opening extending all the way to the foundation. There is a spillway at the right end of the dam, but the logs are not removed at flood time, and the floods have spilled down over the rock walls of the main dam for many years. The stoplogs are removed in the dry season to let irrigation water out into the river channel for diversion below. Storage capacity of the reservoir is small in comparison with the flood runoff of the stream.

True appreciation of these old works requires that the conditions producing them be kept carefully in mind. Each of them represents the efforts of a single landholder to supply his establishment with a water supply during the dry season. The dams probably cost little or nothing in money. Quarrying was done by hand, and the lime was home-burned. The Indian laborers had to be fed and clothed by their overlords whether they worked or not.

Throughout the winter months there is no rain, very little agricultural work is possible, and there were no other public works. The construction of these irrigation structures kept the peons out of mischief and provided a much-needed commodity.

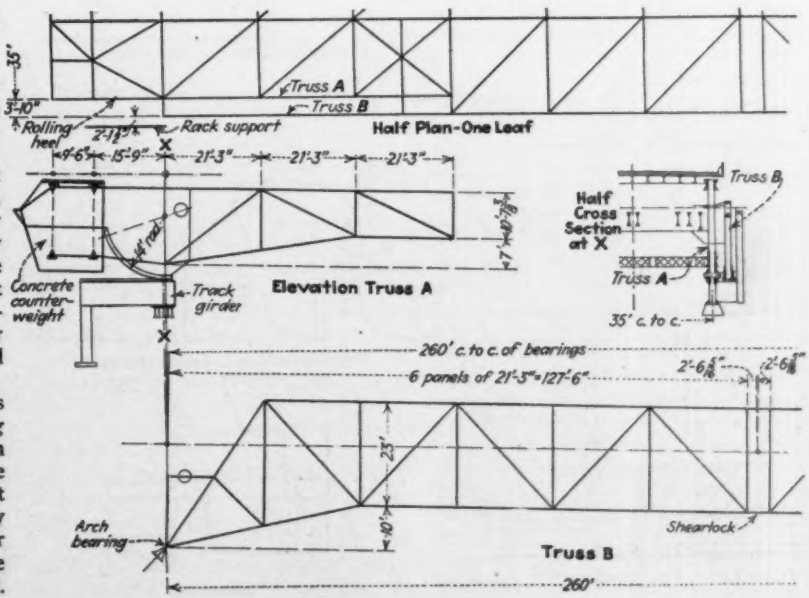
It is with some trepidation that the picture is presented of these old structures standing in apparent defiance of our generally accepted rules for design, and it is hoped that these examples of boldness will not be taken too seriously. It is surprising that failures of these structures have not been frequent, but failures seem to have occurred only in the cases of the most flagrant violation of fundamental principles. Out of perhaps 50 of these structures with which the writer is familiar, three failures are known to have occurred, and two of these resulted from inadequate foundations rather than structural weakness. The most important lesson to be drawn from these old dams seems to be that well-executed work on a good foundation can atone for many faults in design.

Bascule-Arch Span in Philadelphia Toll Bridge

Double-leaf rolling-lift bascule of unusual type in Tacony-Palmyra bridge acts as an arch when closed, instead of forming an independent cantilever with each leaf

A DOUBLE-LEAF rolling bascule span, which acts as a three-hinged arch instead of a pair of cantilevers when closed and under live load, is a distinctive part of the Tacony-Palmyra highway bridge over the Delaware River at Philadelphia, Pa. This bridge, about 5 miles upstream from the Philadelphia-Camden suspension bridge, connects the Tacony section of Philadelphia with Palmyra, N. J., on a state highway route. The main span is a 537-ft. tied arch, adjacent to which is the 260-ft. bascule span, and these two spans are approached on each side by a series of three 245-ft. spans, with trusses continuous over four supports.

Fig. 1—Separate trusses inside the main trusses carry rolling heels and counterweight on Tacony-Palmyra bridge.



Advantages of the arch bascule

The principal advantage of the arch type of bascule, as compared with a bascule span composed of a pair of cantilevers, is its greater rigidity under live loads and particularly under heavy concentrated live loads. Besides this the arch-thrust reaction at the center of the bascule avoids the objectionable whipping deflections between the ends of the pair of cantilevers as the live

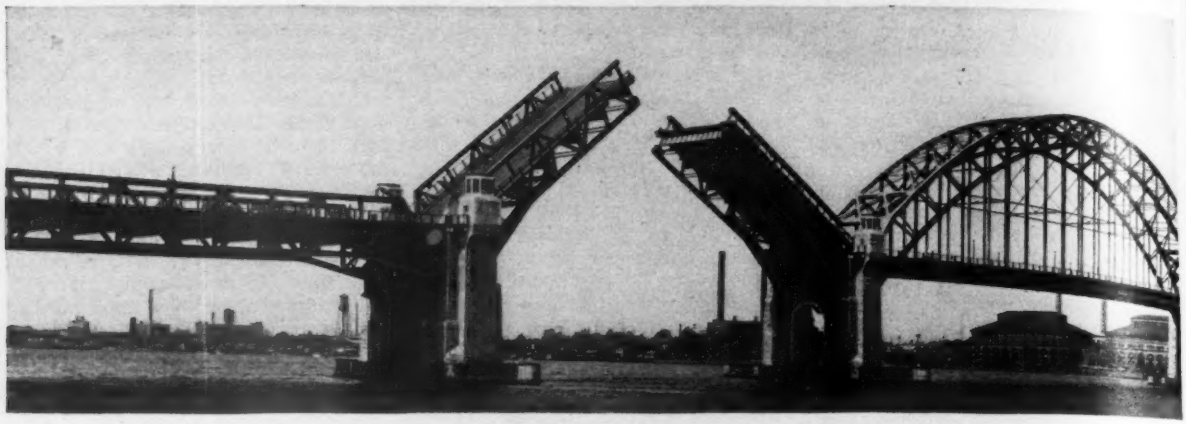


Fig. 2—Rolling-lift bascule that forms arch span when closed.

loads pass from one leaf to the other. The arch requires no anchorage for its live loads and is considered to be generally more economical than a cantilever. Furthermore, the arch has three points of support, while a cantilever with its anchorages has five and sometimes seven when additional front live-load supports are used.

Features of the Tacony bascule

At the heel the main trusses, when closed, are seated against shoe castings or skewbacks on the piers. At the crown cast-steel shoes on the ends of the top chords are in contact. The meeting ends of the bottom chords are arranged on a shear lock to take care of vertical shear. Thus a lug on the face of one chord enters a notch in the end of the opposite chord. At the same time the side plates of the two chords overlap, so as to bring the chords into line and prevent any lateral movement. Trusses projecting beyond the pier ends of the main trusses and forming the tail of the leaf are attached to the segmental rolling girders and carry the machinery deck and the counterweight box. In operation two 60-hp. motors on each leaf, with reducing gears, drive pinions that ride on fixed racks built into the piers.

Each bascule leaf is balanced for its own dead weight of about 1,000 tons, and the leaf is an independent cantilever under dead load only. When the live load comes upon the leaf it causes both leaves to deflect slightly at the center of the span, thus bringing into play the arch-reaction castings on the ends of the top chord. The thrust thus developed is taken by the arch-reaction bearings at the pier ends of the bottom chords to the extent that it is not absorbed by the friction of the rolling segment on the track girder.

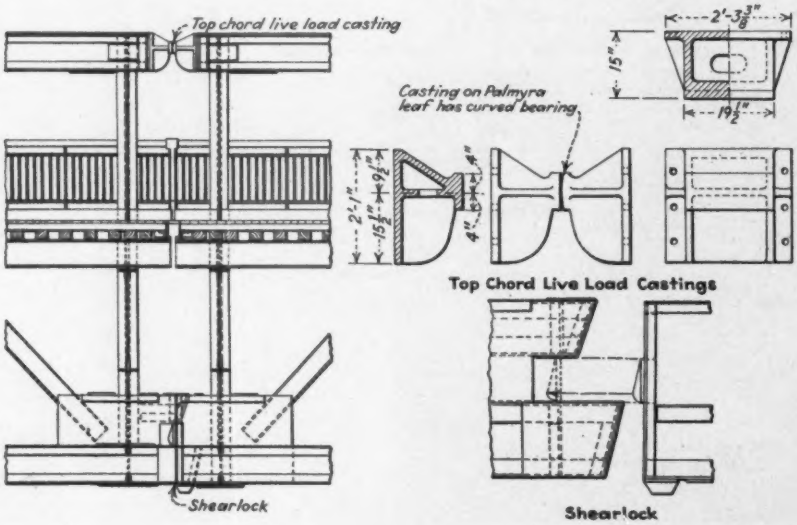
Earlier arch bascules

The advantage of the arch type of bascule span is said to have been recognized early in the construction of a simple trunnion bascule built in England in 1839. The first modern rolling bascule in the United States, built over the Chicago River by the Metropolitan Elevated Railroad Co., Chicago, was designed to carry live load as an arch and covered claims in the patent issued to William Scherzer on Dec. 26, 1893. Anchorages were also provided, and the trusses were designed to act as cantilevers in case the mechanically operated center locks should not prove entirely satisfactory. These center locks were subsequently simplified and perfected, as here illustrated and described.

The 150-ft. eight-track railroad bridge built in four units over the Chicago drainage canal in 1901 was one of the first important bascule arches to be built. Ralph Modjeski was the consulting engineer, and the center lock was covered by patent issued to C. L. Keller on Nov. 5, 1931. The first highway arch bascule was built in Pelham Bay Park, New York, in 1908. But previous to the construction of the Tacony bridge the most important structure of this type was the 310-ft. draw-span of the Market St. bridge built in 1917 over the Tennessee River at Chattanooga, Tenn. In that bridge each leaf weighed about 2,300 tons; the top-chord bearing consisted of 12-in. pins held in bracket plates on the ends of one leaf, while the chords of the opposite leaf had bronze-lined sockets to receive the pins.

Engineers — The Tacony - Palmyra bridge was designed by Modjeski, Masters & Chase, consulting engineers, Philadelphia, Pa., with C. L. Keller, Chicago, as consulting engineer for the bascule span.

Fig. 3—End bearings and locks convert the bascule leaves into an arch when closed.



Public-Works Program, Morocco

The French government has arranged to grant a loan of $55,000,000 for the development of Morocco, and of this sum about $38,000,000 will be spent on a six-years' program of public works. The principal item in the program is an expenditure of 354,000,000 francs ($14,000,000) on irrigation and electric-power supply works. The equivalent of $10,000,000 is to be spent on port and harbor works. $9,000,000 is to be spent on railroad electrification and new lines. A sum of $1,400,000 is to be expended on roads and bridges.

Further Discussion of Unit-Graph Method of Estimating Runoff

Hydrologists and hydraulic engineers present their views on the soundness and workability of the proposed method of computing a hydrograph from rainfall data

IN LAST WEEK'S issue H. K. Barrows, Charles H. Pierce, C. S. Jarvis, C. E. Grunsky, Robert E. Horton, Cecil Boling and George D. Clyde discussed at some length the unit-graph method that had been described by L. K. Sherman in *Engineering News-Record*, April 7, 1932, p. 501. The unit-graph method is a means of computing a runoff history corresponding to a given body of rainfall data. The following article closes with a discussion by Mr. Sherman. —EDITOR.

Short-Time Unit Graphs Now Being Studied

By W. W. Horner
Chief Engineer, Sewers and Paving, St. Louis, Mo.

IT IS EXTREMELY interesting that a number of able engineers have recently been led to approach this phase of hydrology from a logical and rational basis and are no longer content with the acceptance of some of the empirical formulas that have in the past been our sole tools. Mr. Sherman's study seems to me to show unusual ingenuity and presents a surprisingly different procedure for what has heretofore been considered capable of only the crudest solution. He has studied this subject in a great deal more detail than I have ever had occasion to do, and on that account he has apparently justified certain conclusions that we would ordinarily consider as needing more detailed demonstration.

For example, his conslusion that the graph is a constant for any particular drainage area at first hand seems unjustifiably strong, for different uniformities of rainfall on different parts of the area might seriously affect the result if we are required to use an average rate over the entire watershed in making calculations. It would also seem necessary to assume that this theorem would be applicable only where the rates of rainfall were not too divergent. In other words, rainfall from extremely light rains where the losses in pocketing are great or from extremely excessive rains might not conform. closely to the rule.

To me, the most interesting part of the paper is the scheme for developing a percentage factor that will take account of the conditions typical of the month of the year and of the rainfall for a number of days preceding that which produces the flood. Only long use of Mr. Sherman's method would determine how well his factors have been chosen, but certainly the means by which his modifications of the percentage factors are worked out are impressive and to me entirely new.

Mr. Sherman uses the percentage factor under protest, and with this attitude I am in entire agreement. I think it would be well if we could all come to think of runoff as a residue of rainfall and not a percentage; we would be able to think more clearly on the subject as a whole.

The demonstration of this paper as applied to streamflow parallels surprisingly the research work that we have been doing at St. Louis from the runoff of urban areas. Unit graphs using a unit time of 5 min. and applied to the building up of runoffs from separate city blocks were developed in connection with the first analysis of the St. Louis sewer gagings about 1915. The method has been revised and improved by the research engineer who is continuing the study of these records. As yet we have been unable to find that a unit graph can be developed for the runoff from a typical city block that would show similar characteristics for all rates of rainfall. It is possible that this may be due to the artificial character of the surface development, but I am proposing a further study to determine whether the principles Mr. Sherman has outlined may be found to apply also to those small urban units.

* * *

St. Francis River Tests Made For New Method

By Robert W. Gay
Associate Engineer, U. S. Engineer Corps, Memphis District

A FEW DAYS after the appearance of Mr. Sherman's article the writer was requested, as a matter of daily routine, to make a short check of the unit-graph method to determine whether it might be useful in the streamflow investigations occurring from time to time in the Memphis District Office of the U. S. Corps of Engineers. The comments resulting from the study are submitted herewith.

For the unit-graph idea to be effective two conditions must be true within the limits of accuracy of available data.

First, on a given watershed the period of concentration and flow following one day's rainfall is always the same. Perhaps this may be conceded within the limits of accuracy of the problem; but in fact different floods pass downstream with different velocities, and velocity of runoff over natural ground will vary with the conditions of the ground surface, such as vegetation, frost and degree of saturation. Possibly this variation in time of

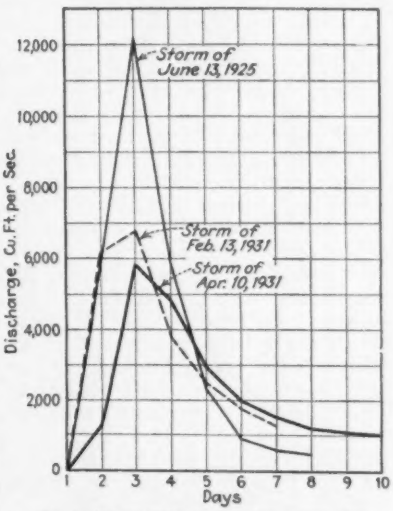


Fig. 1—Three different one-day storms give varying forms for the unit graph for the same stream.

collection may often be overlooked without serious error.

Second, an average runoff of 1 in. (or any other amount) will appear in the stream according to the same regimen of flow, regardless of the concentrations and distribution over the watershed of the rainfall producing it. There appears to be serious question as to the workable accuracy of this assumption. The author says, "The unit graph should be based upon a uniform depth of rainfall over the entire area." He calls attention to the fact that concentrations at one end of the watershed, or the other, change the shape of the unit graph. This being the case, it does not appear that a unit graph based on one system of concentration can be used to compute the effects arising from a storm of different concentration. But it is the basic assumption of the method that one unit graph can be used for a watershed for any storm that may happen thereon.

The following figures are for the watershed of the St. Francis River above Chaonia, Mo., having an area of 1,190 square miles. The length of the watershed is about 65 miles, and its width varies from 16 miles just above Chaonia to 30 miles at a point 40 miles upsteam. The watershed is a portion

of the deeply eroded Ozark Hills area.

Unit graphs were computed for three different one-day storms. The accompanying table shows a part of the results, the unit-graph flows being given for three days. The complete unit graphs are shown in Fig. 1.

THREE DIFFERENT UNIT GRAPHS FOR THE ST. FRANCIS RIVER

Storm Date	Average Rainfall, In.	Average Runoff, In.	Unit Graph—Rates of Flow, Sec.-Ft. 1st Day	2nd Day	3d Day
April 10, 1931	1.20	0.42	1,260	5,820	4,840
June 13, 1925	2.95	0.80	5,750	12,110	5,850
Feb. 13, 1931	0.74	0.32	6,085	6,790	3,910

The first storm delivered about twice as much rain on the southern end of the watershed as on the northern end. The second storm delivered about six times as much on the southern end as on the northern end. The third storm was remarkable for its uniformity over the whole watershed. Of the three the last one conforms best to the requirements of a unit graph as stated by the author, except that the total amount of rainfall was somewhat small. If the method is to hold, these three unit graphs should show essentially the same results, but inspection shows considerable difference. In practice, any of these storms might have been picked to develop the unit graph, although the last one is admittedly the most suitable from the standpoint of the distribution of rainfall.

In applying the graph to the construction of a storm hydrograph the method requires that an estimate be made of the percentage of each day's rain which appears as runoff. The difficulty of making this estimate is considerable. The author outlines an empirical method consisting of evolving a curve for each month of the year, which shows the percentage of runoff, as ordinates, corresponding to depths of rainfall plotted as abscissae. In order to plot these curves it is necessary to have records of rainfall and runoff available for from three to six storms for each month for which a curve is desired. They must be of such intensities as to cover the probable range of rainfall and must occur in such manner as to allow fairly good segregation of runoff from preceding or following storms. The experience with the St. Francis watershed indicates that a very considerable record must exist to supply the necessary data for a moderately reliable curve. Eight years of gage records did not furnish data for a curve for February. It was necessary to assume that a curve could be made for two-month periods, and even here the results were not good.

It was assumed that a curve could be made for the months of March and April, but the points were so erratic that a single curve would not fit them. In fact three different curves, as shown on Fig. 2, might be indicated.

In developing the computed hydrographs mentioned hereinafter curve 1 was used for the April, 1927, storm; but there seems to be no reason for its selection over either of the other two, and the rates of runoff will be quite different for the various curves.

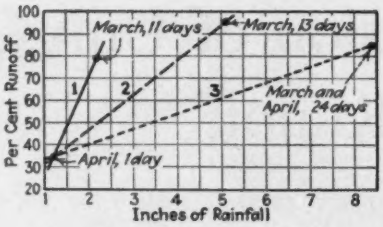


Fig. 2—Relation between runoff percentage and rainfall intensity is erratic. Any one of three possible curves could be used.

In making the search for storms from which to develop these runoff relations several unusual situations were found. In the months of July, August and September, 1930 and 1931, rainfalls ranging from 0.5 to 1.5 in. and monthly totals running as high as 4 to 5 in. produced such small reaction on the gage as to be negligible. In other instances rises of from 0.5 to 1.5 ft. in a low or moderate gage occurred with no recorded rainfall on the watershed. This indicates that the rainfall stations are not numerous enough. Four stations on the watershed and four or five around its edge were used.

In spite of the uncertainty of the unit graphs and the runoff curves, an attempt was made to reproduce, by their use and from rainfall records, the hydrograph for the period March 28 to April 29, 1927. Fig. 3 shows the actual and computed hydrographs based on two unit graphs.

The results are not encouraging. Perhaps the most noticeable feature is with respect to the March and April, 1927, period. The total rainfall on the watershed averaged 12.58 in., and up to April 21 there were only two days that gave no rain anywhere on the watershed. Runoff curve 1 of Fig. 2 was used and gave higher runoff percentages than judgment would perhaps indicate. The computed hydrographs show considerably less runoff than the actual hydrograph.

The storm period followed a wet winter, and relatively large runoffs were to be expected. However, there was evidently some rainfall that was not recorded at the stations, for the actual runoff was 104 per cent of the rainfall. An average rainfall of 12.58 in. on the watershed would give 319,400 day-sec.-ft. (638,800 acre-ft.) of runoff, if a runoff factor of 80 per cent is assumed. It should be noted for the credit of the computed hydrographs that one gives a runoff of 656,000, and the other gives 620,000 acre-ft. Neither of these figures is far from the 80 per cent runoff stated above based on rainfall; and their average is 638,000 acre-ft., a rather remarkable check.

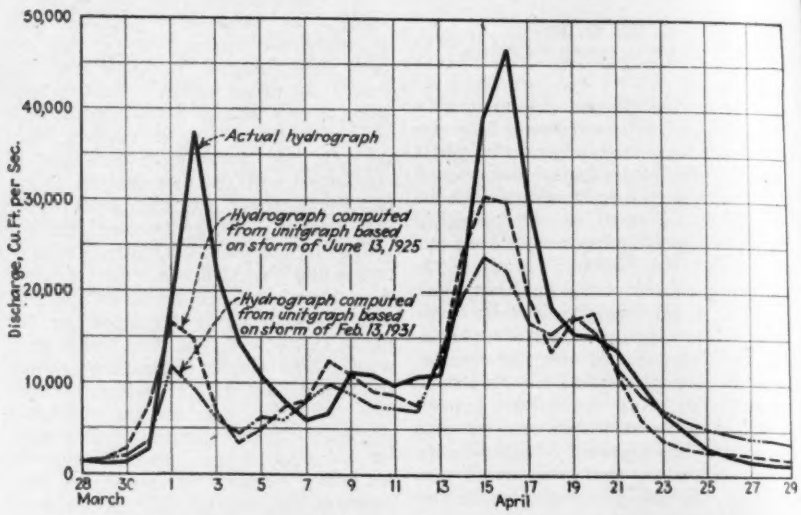

Discharge, Cu. Ft. per Sec.
Actual hydrograph
Hydrograph computed from unitgraph based on storm of June 13, 1925
Hydrograph computed from unitgraph based on storm of Feb. 13, 1931
March
April

Fig. 3—The unit-graph method applied to the watershed of the St. Francis River at Chaonia, Mo.

It may be that there is a field for the method in the development of hydrographs for hypothetical storms, where average rainfall and runoff percentages can be assumed and where results would otherwise have to be guessed. The St. Francis figures seem to indicate that total runoffs can be estimated more nearly than peak rates, for long wet periods.

On the whole, while the idea of the unit graph is intriguing, the writer doubts whether the method adds greatly to present methods. Where records are available for a sufficiently long time to enable a proper development of unit-graph and runoff curves, it may be questioned whether other present methods are not as reliable and quicker.

There are theoretical objections to the basis on which the method is developed; but since the method makes no claim to be more than an empirical one, actual comparison with a fairly large number

of actual cases is the only proper basis for its acceptance or rejection. If it fits in a sufficiently large number of cases, it would be recognized, with perhaps a limited application. The St. Francis results are not as encouraging as they might be, but they are submitted as one example, with the hope that more evidence will be forthcoming from other sources.

* * *

Applied to Southern Streams, Results in Inaccuracies

By Thorndike Saville

Professor of Hydraulic and Sanitary Engineering, New York University, New York, N. Y.

WHEN Mr. Sherman's article appeared, it seemed worth while to study it carefully with regard to its applicability to North Carolina streams, as previous methods advanced by other authors had not been found at all satisfactory. J. P. Clawson, assistant engineer of the North Carolina department of conservation and development, spent some ten days in attempting to apply Mr. Sherman's method to flow from drainage areas in the state for which rainfall and runoff were accurately known. The results have been entirely negative.

The fundamental novelty in Mr. Sherman's article consists in his method of determining per cent of rainfall appearing as runoff. Efforts were made to apply this method to runoff from the Flat River near Bahama, N. C. The drainage area is 150 square miles, the gaging station is equipped with an automatic recorder, the control is of concrete with a weir for low flows, and the rating is excellent. There is no ice. The record is believed to be highly accurate. There are three rain gages on the drainage area above the station, and estimates of rainfall on the area were made by the Horton method.

With the utmost effort to follow Mr. Sherman's method in detail, the computed hydrograph bore no resemblance to the observed hydrograph. The computed floods were far smaller than those observed. Attempts were then made to apply the method to runoff on Morgan Creek near Chapel Hill (drainage area, 27 square miles). Results were equally unsatisfactory. Still a third effort was made for the Haw River at Pittsboro, N. C. (drainage area 1,340 square miles), with no better success.

Being puzzled by the utter discordance between the computed and the observed data, the writer sought to find the real accuracy of the example Mr. Sherman presented for Muddy Creek at Plumfield, Ill. The diagram that accompanied his article hardly presents a sufficient picture of the discrepancies between observed and computed data. Observed data are to be found in *Water-Supply Paper 645* of the U. S. Geological Survey, p. 110.

It is evident from the data that on a stream presumably selected as susceptible of analysis by the method advocated, and with data treated by one completely familiar with the method, the results of the computed daily flow may readily be from 50 to 30 per cent in error. It may be alleged that the flow for the total period of 51 days is only 6 per cent in error, but this has no significance, for very large positive errors in the computed data tend to balance equally large negative errors. It does not appear to the writer that the method as applied even to the example selected by Mr. Sherman is within reasonable limits of accuracy for use in hydrological studies.

Mr. Sherman makes the statement that in a given month and taking into consideration prior rainfall the per cent of a given rainfall appearing as runoff is a constant. This is not borne out by data applying to the Upper Flat River basin. The great discrepancies found in attempts to apply the unit-graph method to Flat River runoff are due largely to inaccuracies arising from use of the generalized runoff curves.

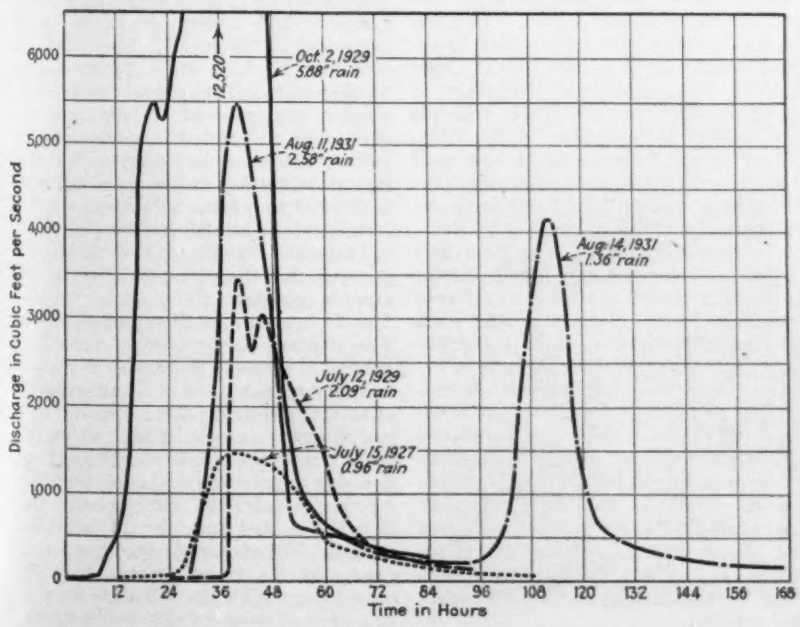
The great and hitherto insurmountable difficulty in attempting to apply a percentage factor to rainfall to produce runoff is well exemplified by the table on p. 258. There is no consistency in the relationship of rainfall to runoff for a given month in different years. Still less will there be any constant correlation between rainfall and runoff for shorter periods. Of course, as Mr. Sherman truly states, if we are able to evaluate correctly the effect of prior rainfall and other factors, we may obtain accurate estimates of runoff from rainfall. It is because the evaluation of these factors is so exceedingly complex that the writer believes no one yet has devised a method of performing it that will be generally applicable.

The computation of the unit graph, which forms the basis of Mr. Sherman's graphical study, is almost impossible to do accurately, at least for streams in the south. Mr. Sherman uses a flood due to a 24-hour rain to compute his unit graph, which extends from eight to ten days. Rainfall subsequent to that causing the flood is corrected in preparing the unit graph, but such rainfall (on a 24-hour basis) is quite small, and large errors in the correction to the unit graph for such subsequent rainfall affect very little the final shape of the unit graph.

On Morganon Creek the floods last only from 24 to 32 hours. Hence one must use rainfall periods of less than 24 hours. If one uses, say four-hour rain periods, it is necessary to correct for rains in subsequent periods, but here such rain is large in amount and greatly affects corrections to the unit graph. The flood is caused by all the periods of rain, and hence it is virtually impossible to make accurate correction to obtain the unit graph by the Sherman method.

Furthermore, the rains causing floods on Southern streams in summer (when the larger floods usually occur) are very unevenly distributed as to time of occurrence of intense precipitation. Data for 24-hour rainfall, as given by the Weather Bureau, are far from indicating the period of a few hours, or even a fraction of an hour, during which most of the rain fell. Also such periods will not sychronize on the same drainage basis. To obtain rainfall data to construct accurately the unit graph for Southern streams having drainage areas less than 500 square miles would neces-

Fig. 4—Typical flood hydrographs of the Flat River, near Bahama, N. C.



sitate a considerable number of recording rain gages on each drainage area. This is hardly practicable.

Even when 24-hour rainfall is adequate to determine the unit graph, great caution must be used in taking data from Weather Bureau tables. Rainfall for the preceding 24 hours is frequently measured at about 5 p.m. At other stations it is measured at about 8 a.m., and at regular Weather Bureau stations it is given for the period from midnight to midnight. Such variations in time of occurrence at stations on a given drainage area are frequently impossible to correct to obtain comparative data for the same time intervals. This is an illustration of need for much more careful consideration by the Weather Bureau of uses to which its published data may be put by engineers.

The writer feels that the methods advocated by the committee on floods of the Boston Society of Civil Engineers and by Mr. Sherman constitute important and significant ideas relating to investigations of streamflow. It is doubtful, however, if these hypotheses have been sufficiently tested to be applied with assurance even in the region for which data used by them have been obtained. In other parts of the country, particularly in the non-glaciated regions of the South and West, very erroneous results may attend any attempt to use these methods without considerable modification. It is desirable that much more study be given to the basic concepts underlying the hypotheses with a view to determining if they may be so modified as to be generally applicable.

RAINFALL-RUNOFF RELATIONS,
FLAT RIVER AT BAHAMA, N. C.

(Drainage Area 150 Square Miles)

Year	Rainfall, Weighted	Runoff, Inches	Retention, Inches	Runoff, Per Cent
		January		
1927	1.23	0.47	0.76	38.2
1928	1.81	0.61	1.20	33.7
1929	1.25	0.20	1.05	16.0
1930	3.14	1.37	1.77	43.6
1931	2.17	0.73	1.44	33.6
Mean	1.92	0.68	1.24	35.4
		February		
1927	3.33	1.35	1.98	40.5
1928	2.13	1.55	0.58	77.7
1929	5.82	2.58	3.24	44.3
1930	1.12	1.69	—0.57	150.8
1931	1.45	0.31	1.14	21.4
Mean	2.77	1.50	1.27	54.0
		March		
1927	2.75	1.64	1.11	59.6
1928	3.10	1.63	1.47	52.6
1929	4.99	3.68	1.31	73.8
1930	1.72	0.64	1.08	37.2
1931	3.56	0.94	2.26	26.4
Mean	3.22	1.71	1.52	53.0
		April		
1927	2.39	0.70	1.69	29.3
1928	6.31	3.34	2.97	52.9
1929	5.16	1.95	3.21	37.8
1930	2.21	0.64	1.57	29.0
1931	4.75	2.32	2.43	48.8
Mean	4.16	1.79	2.37	43.8
		May		
1927	1.40	0.17	1.23	12.1
1928	2.75	0.96	1.79	34.9
1929	4.11	0.87	3.24	21.1
1930	4.64	0.78	3.86	16.8
1931	6.70	2.51	4.19	37.4
Mean	3.92	1.06	2.86	27.0
		June		
1927	3.75	0.22	3.53	05.9
1928	4.07	0.65	3.42	15.9
1929	5.66	0.83	4.83	14.6
1920	3.42	0.31	3.11	09.1
1931	3.03	0.32	2.71	10.6
Mean	3.99	0.57	3.52	11.7
		July		
1927	6.61	0.76	5.85	11.5
1928	2.90	0.16	2.74	05.5
1929	3.27	1.10	2.17	33.6
1930	5.65	1.19	4.46	21.1
1931	4.03	0.33	3.70	08.2
Mean	4.49	0.71	3.78	15.8
		August		
1927	6.02	0.57	5.45	09.5
1928	6.49	0.67	5.82	10.3
1929	8.59	1.21	7.38	14.1
1930	2.02	0.12	1.90	05.9
1931	9.90	2.48	7.42	25.1
Mean	6.60	1.01	5.59	15.7
		September		
1927	1.77	0.54	1.23	30.5
1928	6.68	2.83	5.85	32.6
1929	3.43	0.30	3.13	08.7
1930	2.06	0.08	1.98	03.9
1931	7.95	0.15	7.80	02.0
Mean	4.78	0.78	4.00	16.3
		October		
1927	3.98	0.48	3.50	12.1
1928	1.08	0.31	0.77	28.7
1929	7.06	3.88	3.18	55.0
1930	2.35	0.02	2.33	00.1
1931	1.38	0.09	1.29	06.5
Mean	3.17	0.96	2.21	30.3
		November		
1927	1.63	0.39	1.24	23.9
1928	0.62	0.18	0.44	29.0
1929	3.55	1.26	2.29	35.5
1930	2.28	0.05	2.23	02.2
1931	7.44	0.06	7.38	01.0
Mean	3.10	0.39	2.71	12.5
		December		
1927	5.10	2.95	2.15	55.8
1928	0.96	0.18	0.78	18.7
1929	1.85	1.14	0.71	61.6
1930	3.47	0.41	3.0o	11.8
1931	4.68	0.26	4.42	05.6
Mean	3.21	0.99	2.22	30.8

* * *

The Author Replies

By L. K. Sherman
Consulting Engineer, Chicago, Ill.

THE AUTHOR appreciates the interest and valuable criticisms that have been presented on the unit graph method. Several of the writers have discussed the factors that forbid the application of the unit-graph principle to runoff because of melting snow or runoff during freezing periods. In these cases conditions other than those specified would have to be used. G. D. Clyde and C. E. Grunsky note difficulties in application of the unit-graph principle to certain arid districts in the West. Their point is well taken, at least until the natural laws governing the percentage of runoff have been better developed.

In the derivation of data for a unit graph it is important to use as far as possible a rainfall uniformly distributed over the basin. Such a graph, when applied to rainfalls of unequal distribution, will show the least departures between observed and computed hydrographs of runoff. Variations in intensity of rainfall during the unit-time period have a minor effect on the accuracy of the method. The author's experience coincides with R. E. Horton's observation: "Variation in rain intensity . . . is largely integrated and eliminated by surface detention or sheet flow." (Called "pondage" in the original article.)

R. W. Gay has applied the unit-graph method to a drainage basin in the Ozark Hills above Chaonia, Mo., with disappointing results. He has evidently made a painstaking application, but, there is evidently some error in his derived unit graphs. By definition, a 1-in. unit graph for a drainage area of A square miles incloses an area equal to A in.-miles. The shape of the graph will be distorted when the distribution of rain is very unequal, but all 1-in. unit graphs must contain A in.-miles. No unit graph should be applied to a rainfall record unless it checks with this rule. The area of each of the 1-in. unit graphs for the Chaonia basin must be 1,190 in.-miles, or 32,000 sec.-ft.-days. The unit graph shown for Feb. 13 (day of uniform rain) is only about 23,000 sec.-ft.-days. Possible snow or ice conditions are not mentioned. As the unit graph is in error, the application is also in error. Referring to Mr. Gay's percentage-of-runoff diagram, the author does not consider that the four points of rainfall are erratic. A smooth curve may be drawn through the plotted percentage points—0, 34, 79 and a mean of 95 and 85. This curve would correspond closely with the upper Delaware percentage curve shown by the author. Mr. Gay obtains three different curves only by neglecting half of his data. His selection of curve 1 is logical because it is the only one of his three lines that approaches a portion of a curve utilizing all of the data.

Messrs. Clyde, Horner, Horton and Saville refer to the author's use of a "percentage" of runoff, and Mr. Clyde states: "Runoff is not a percentage of rainfall." The depth of surface runoff, excluding base flow, may be stated either as an amount or as a percentage of an amount of rainfall. The results are identical. The author's percentage curves may be readily converted into a diagram of depth of rain plotted against runoff. Such a diagram in the form suggested by Charles H. Lee, (*Trans.*, Am.Soc.C.E., Vol. 94, p. 1,296) seems to offer a procedure that may materially simplify the problem. It seems to accord with the author's conclusions in plotting his percentage diagram that the rate of infiltration and losses on a given basin tend to become a constant after a certain rate of rainfall has been reached.

Thorndike Saville gives a tabulation showing that the percentages of runoff are not constant for a given month. This is irrelevant to the author's paper. The standardized practice of recording rainfall as a runoff percentage is almost meaningless. At best it is an average of several different percentages for several different storms. It is in error because it includes surface runoff and base flow due to precipitation in the previous month. It takes no cognizance of the distribution and intensity of previous rainfall. The author obtained consistent results in his runoff curves only by considering: (1) individual rainfalls, (2) effect of prior rainfall and distribu-

tion, and (3) elimination of base flow. The author's rule for prior rainfall (Table III in the original article), as he states, is only roughly approximate. Further research is much needed and will increase the accuracy in estimating runoff. The author is inclined to agree with Mr. Clyde that percentage of rainfall is not a good expression.

C. H. Pierce apparently has overlooked all of the author's reference to variation in runoff when he states: "Unfortunately for the accuracy of the method . . . the size and shape of the runoff hydrograph . . . will vary with the time of year." The author is quite aware of the factors mentioned. Mr. Pierce cites the case of May, 1927, and September, 1930, where the total rainfall was practically the same for each month—7.8 in. He propounds the question: "What is the runoff by the unit-graph method for September 1930?" By use of the author's percentage curve at Plumfield for July, which is the nearest data that he has available, and applying the rule in Table III, the answer to this question is 0.93 in., compared with 0.45. in. observed. For the application of the unit graph derived at one season and applied at another, the author refers to his Fig. 4, where a unit graph derived in November, 1926, was applied to rain in August, 1928. Referring to the comments of Mr. Pierce on the four laws of the hydrographs, his point on the first one is correct. The author should have added, "When variation in base flow is taken into account." The second and third laws have already been commented upon. The second law is not a fallacy.

Messrs. Pierce and Saville point out a number of inaccuracies in comparing the observed with the computed rates of runoff and conclude that the results are unreliable. Others refer to the results as "in fair accord." The examples, comparing computed with observed hydrographs of flow, include and reflect all the effect of unequal distribution and varying intensity of actual rainfalls when compared with the computed hydrograph based on assumed average distribution and uniform intensity of rainfall during a unit period of time. The examples also reflect the errors in estimated percentage of runoff as well as any errors in recorded streamflow. The author offers no apologies for his computed figures. The diagrams speak for themselves and fairly represent what the unit-graph method will and will not do under the present development of the science of hydrology.

Mr. Horton cites the work of Lueger but does not refer to some of his own studies on hydrographs: "Flood Reduction by Reservoirs," paper 4,483, Inst. ofC.E., 1924, or his unpublished paper, "Surface Runoff Phenomena." Col. C. R. Pettis and H. C. Graville have also presented papers relating to the hydrograph.

H. K. Barrows and Thorndike Saville cite the report of the Boston society's committee on floods. This is one of the most constructive investigations that have ever been presented upon the laws of the hydrograph. The conclusion, as to constant length of the hydrograph for a given basin, has been confirmed and used by the author of the unit graph. The deviation of this law at very low runoff rates does not materially offset the accuracy of results. The author is glad to have these citations to the work of other pioneers. It removes some of the curse of being unorthodox.

Mr. Saville's comments on the application of 24-hour rainfall records are well taken. The author has had similar experience. Flat areas of less than 500 square miles and areas with steep topography require a unit-graph time much shorter than 24 hours. Areas of 100 square miles require unit-time graphs as short as two or four hours. The author perhaps should have emphasized this in his paper. With this in mind, Messrs. Gay and Saville might perhaps have secured better results in their applications.

Much of hydrology as a science is in an embryonic stage. Its advancement will come as it is segregated into its basic laws, as the author of the unit graph has done, and not from scrambling it into the single law of probability.

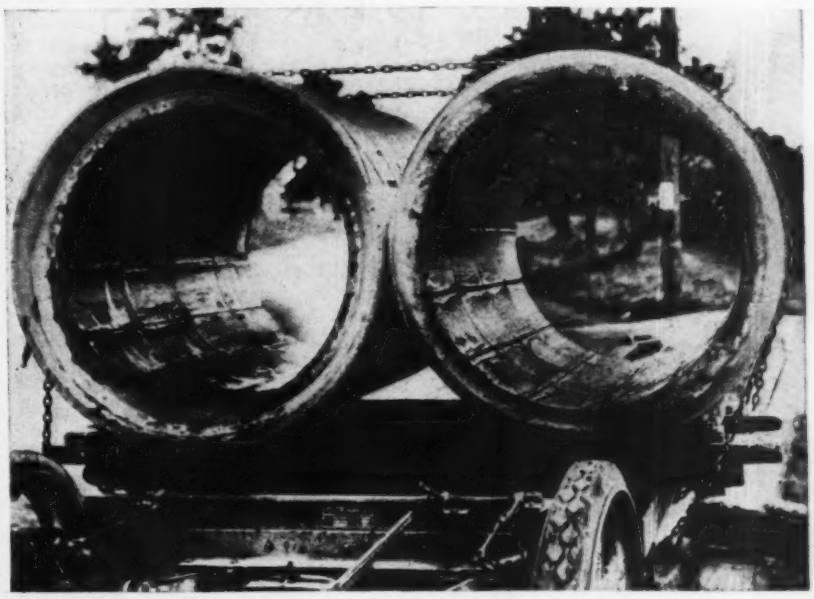
Clay Liner Plates Embedded in Sewer Pipe to Resist Septic Action

New sanitary relief sewer in Kansas town is of precast concrete pipe reinforced with field-welded cage of small bars

THE LARGER sizes of pipe in the system of relief sanitary sewers in Hutchinson, Kan., recently renewed, are of reinforced concrete with clay-tile lining. Flat grades contribute to the formation of septic action through holding the sewage in the sewers a long time. This septic condition together with destructive action of industrial wastes has caused concrete pipe thirteen years old to disintegrate, particularly on the upper third of the pipe. The clay-tile liners together with a dense type of concrete are used to alleviate the disintegration that was so widespread as to occur in a headwall at the outfall that has never come in contact with the liquid sewage.

Hutchinson, Kan., has two main outfall sewer lines leading to the Arkansas River. The Severance St. outfall line is of concrete (monolithic construction) built in 1914 and 1915. This line runs from the intersection of Cow Creek and Severance St. south to the Arkansas River. It is 30 in. in diameter and has a wall thickness of 5 in. The concrete is a sand-gravel mix. Steel bars were used as reinforcing instead of mesh. About 90 per cent of the domestic sewage of the city is collected and run through this outfall line. Also some industrial waste is carried, such as waste

Lined 42-in. pipe on truck ready to be hauled to ditch.



Reinforcing cages were welded in the field and fitted over pipe mandrel after liner plates had been placed.

from a small packing plant, a creamery, a laundry and one salt well.

The Halstead St. 42-in. outfall line, of reinforced concrete (monolithic construction), runs from the strawboard plant, or Sherman St., south to the Arkansas River. This line was built during the winter of 1919 and carries waste from a large packing plant, a strawboard plant, the Santa Fe Railway shops and a soda-ash plant, plus about 10 per cent of the domestic flow of the city.

During 1930, 1931 and 1932 an intensive study made of the sanitary sewer condition in the city disclosed that these two outfall lines were in exceptionally bad condition. This was especially true of the industrial line in which holes were eaten through the upper half of the pipe large enough for a man to crawl through. For 1½ miles the upper third is so cracked and deteriorated that it may fall in at any time. The Severance St. line has several holes eaten through it, and the upper third is in a very poor condition, so that this line will have to be rebuilt.

Liner plates wired around inside form ring of pipe. Note the small strip for ease in removing inside form.

Last fall the city officials decided to build new relief and outfall mains. After considerable study it was decided that all mains having a diameter of 30 in. or more should be built of reinforced-concrete pipe with vitrified-clay liners. On Feb. 5 the Stamey Construction Co., of Hutchinson, Kan., was awarded a contract for 3,400 ft. of 30-in. pipe, 2,300 ft. of 33-in. pipe and 2,000 ft. of 42-in. pipe.

General specifications of the clay-lined pipe call for wall thickness, including the liners, of 5½, 5 and 5 in., respectively, for 42,- 33- and 30-in. sizes. Steel area per foot of pipe, not including cross-wires, is 0.260, 0.173 and 0.146 sq.in., respectively. The specified crushing loads of these same sizes at 28 days were 3,900, 3,100 and 2,700 lb. per linear foot of section to be tested in three-edge bearing (A.S.T.M. standard). Minimum results showed 4,166, 3,800 and 3,000 lb. per foot respectively.

The concrete mixture contained a water-cement ratio not exceeding 6½ gal. per sack of cement, making a product that weighed 147 lb. per cubic foot. Mixing time was 2 min. Joints between the liner plates and between the pipes are painted with an emulsified asphalt. The paint was the only kind submitted to the engineers that would withstand a test of 90 min. in sulphuric acid and 30 min. in plain gasoline.

In construction the liners are fastened to the inner forms (of cast iron) by wire, then the reinforcing is placed around the liners, and the outer form ring is set in place. Concrete is then deposited, tamped and left to set four hours, when the inner ring is removed. The outer form remains in place for 24 hours. At the end of 48 hours the pipe is removed from the cast-iron pipe, laid down and shoved into the supply yard to cure, a process in which the pipe is sprinkled at least twice a day for ten days.

The relief sanitary-sewer system was designed and installed under the direction of A. W. Hefling, city engineer.

Novel Telescoping Tremie Tube Is Manually Operated

Lower half, a 9-in. sheet-iron pipe, slides on upper stationary half, consisting of the hopper and a section of 8-in. pipe

By C. J. Brownell

Assistant Bridge Construction Engineer, State Division of Highways, Sacramento, Calif.

A HAND-OPERATED tremie tube for placing concrete under water, where the working conditions were such as to make it impossible to use a mechanical hoist, proved unusually successful in connection with the recent repair of a timber trestle bridge. On this structure concrete piers with tremie concrete bases and a timber truss replaced five original timber bents. The plans called for utilizing the existing deck and for maintenance of traffic over the bridge during construction. The falsework required to support the deck during the construction of the footings reduced the available headroom to about 22½ ft. from the bottom of the excavation. The depth of the water was 4½ ft. at one pier and 10½ ft. at the other. The mixer was set on the bridge floor, and the concrete was lowered in chutes.

At the suggestion of the writer the contractor constructed a tremie tube composed of two parts. The upper or stationary part consisted of the hopper and a section of 8-in. pipe. The lower or movable part was a section of 9-in. sheet-iron pipe, the length of which was about 6 in. more than the greatest depth of water. The parts were assembled so that the lower or movable section telescoped over the upper or stationary section. The end of the concrete chute was tied under the bail of the hopper, and the entire assembly swung on a tackle from an overhead timber.

Hand-operated tremie tube in which lower part telescopes over upper half, which is fixed to hopper.

The following sequence of operations was found to be simple and easy. Both sections were first raised to the maximum height. The tube was sealed and partly filled with concrete, after which both sections were lowered several feet with the tackle. The movable section was then lowered to the bottom of the excavation, the seal was released, and the flow was started by raising the movable section slightly with the handles at its upper end. When desired, the flow was stopped by pressing the movable section into the concrete already deposited. After very little practice the operators were able to regulate the outflow from the tube so that it was just equal to the inflow at the hopper. As the concrete was flowing through the tube the operators could swing it from side to side to cover the entire width of the footing. While the next batch was mixing there was ample time to move the assembly ahead along the overhead timber. In order to do this without losing the prime, the lower section was allowed to remain embedded in the concrete already placed, while the upper section was raised as high as possible by means of the tackle. A chain sling was then placed from an advanced position on the overhead timber to the bail of the hopper, and the tackle was released and moved ahead.

Several points were noted in the operation of the tube. Two men working on a scaffold just above the water were able to handle it easily. The friction of the concrete slipping through the lower section was just sufficient to carry that section down until it shut off the flow. The only action necessary on the part of the operators was to lift the handles enough to overcome the friction and the weight of the section. With the hopper full of concrete, it was found that the space between the two pipes filled with a fine cement grout. This served as a splendid lubricant for the sliding part. It further acted somewhat as a gage to indicate when the tube was nearly empty of concrete. It was found that with the lower section lapping about 3 ft. over the upper and with the hopper full of concrete, the level of the grout between the pipes was a few inches below the top of the movable section. With less lap the grout would ooze out between the pipes; with more lap the grout would still work nearly to the top of the lower section. Concrete with a slump of 6 to 7 in. was found to be the easiest to handle, a wetter mix running out between the two sections and a dryer mix having a tendency to stick in the hopper.

When the depth of the water was 4½ ft. it was possible to get the lower end of the tube entirely out of the water. In this case it was sealed by a padded board placed over the bottom of the lower section and held in place by ropes extending to the handles at the upper end of the section. At the other pier, with both of the tubes in their highest possible positions, the lower end of the movable section was still several feet under water. Since the end could not be sealed as described above, a burlap wad was used. This wad was pushed through the 8-in. pipe and into the 9-in. pipe but not down to the water level, being prevented by a rope running back through the hopper and held by an attendant. The weight of the concrete was sufficient to push the wad through when the rope was released. The wad and control rope were removed from the seal by means of a second rope from the wad through the bottom of the tube.

Letters to the Editor

Sewer-Pipe Failures

Sir—Reference is made to "Pipe-Sewer Failures in the Chicago Region" by Mr. Paul E. Green (*ENR*, July 7, 1932).

The cause of unreinforced pipe failures has been made the subject of a rather extensive investigation in the Los Angeles area, with the result that the following conclusions have been reached:

1. Pipe manufactured strictly in accordance with standard strengths specified in A.S.T.M. C-13 & 14-24 are unsafe in trenches where the depth of backfill over the crown of the pipe exceeds 7 ft., even though the trench at the pipe crown be limited to a maximum width equal to the pipe's outside diameter plus 16 in. In the foregoing it is assumed that the working strength is two-thirds of the required test strength.

2. One of the principal reasons for pipe failures is the indiscriminate use of A.S.T.M. specification pipe in trenches where the backfill imposes a load which the pipe is not built to support—i.e., the indiscriminate use of standard pipe without reference to its strength.

3. Many pipe lines now intact owe their stability to the fact that the pipe manufacturer, in his desire to make pipe strong enough to fulfill adequately A.S.T.M. requirements, has built pipes much stronger than specification requirements.

4. Placing A.S.T.M. specification pipe in a concrete cradle is more expensive to the owner than building pipes to withstand pressures in trenches to a 20-ft. depth and laying them unsupported. Also, the latter type of construction will yield the pipe manufacturers a greater over-all profit on the job.

5. Unless maximum trench widths are specified in line construction, the designer is without adequate data upon which to base conclusions as to pipe-strength requirements.

With the above facts in mind, a conference of Los Angeles City, Los Angeles County and Los Angeles County Sanitation District engineers met with engineering representatives of the local pipe companies and concluded upon specifications that provide greater shell thickness in pipes, calculated to develop the strength necessary to withstand trench loadings of 10-ft. maximum depth for standard-strength pipe and 20-ft. maximum depth for extra-strength pipe, assuming a ratio of working strength to required test strength of two-thirds to one, in trenches of limited maximum width at pipe crown. The specifications are tentative and are at present undergoing the test of application. The present outlook indicates that there will be few changes and those only of minor importance.

In general, the undersigned agrees with Mr. Green in his conclusions but believes that, with pipe actually designed and trench width carefully controlled, concrete cradling is merely incidental to most pipe-line construction and important only in extreme cases. The belief is also stated that there should be little if any difference in the allowance for infiltration as between pipe sizes, because as the pipe diameter increases and with it the size of bell and socket the difficulties of good field work decrease, with resultant better joint construction.

The writer expresses the opinion that the liability for pipe failures lies at the door of the engineer more often than not, and that analysis of loadings commonly encountered in sewer and storm-drain construction will speedily convince the engineer of the restricted field in which A.S.T.M. pipe may be used unassisted.

In congratulating Mr. Green upon his timely article the writer desires to indorse particularly Mr. Green's conclusions 1 and 3; to stress the need of accurate design of the pipe structure as a whole; and to indicate that there are very definite limitations to the free use of A.S.T.M. specification pipe, particularly so if any reasonable safety factor is applied.

A. M. Rawn,
Assistant Chief Engineer,
County Sanitation Districts of
Los Angeles County.
Los Angeles, Calif.,
July 30, 1932.

Editor's Note: In the copy of the specifications accompanying Mr. Rawn's letter the following shell thicknesses were recommended:

Size, In.	Cement Concrete Pipe: Standard Strength, In.	Cement Concrete Pipe: Extra Strength, In.	Vitrified Clay Pipe: Standard Strength, In.	Vitrified Clay Pipe: Extra Strength, In.
6	¾	¾	¾	¾
8	¾	¾	¾	¾
10	1	1	1	1
12	1¼	1¼	1¼	1¼
15	1¼	1¼	1¼	1¼
18	1⅜	2	1½	2
21	1½	2¼	1¾	2⅛
24			2	2¼
27			2¼	2½
30			2½	2¾
33			2¾	3
36			2¾	3¼

Engineering News-Record

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A Result of Working Together

PRIVATE and public transit interests have shown excellent coordination in planning the solution described in this issue of the difficult passenger movement problem of Newark, N. J. The city, the state, the street railway and bus lines and a leading railway handling commuter traffic to New York have functioned together effectively in relieving a condition of street congestion that was becoming intolerable. The combination of physical improvements by which the task is being accomplished is explained in the article. Important as the engineering structures are, they are secondary to the meeting of minds by which normally divergent transit interests have come to harmonious agreement and action in carrying out a notable public improvement. Such success gives confidence in the wide possibilities of coordination for clearing up difficult transit situations that exist in all large centers of population. In every case the engineering plan will follow logically if the various transit interests are earnestly determined to work together for improvement.

The Disappearing Township Road

INDIANA has joined Michigan in eliminating the township as a highway administrative unit. Indeed, according to the news item in another part of this issue, the state legislature, which has recently adjourned from special session, appears to have enjoyed a field day in public-roads lawmaking. The significant fact of this legislation is that apparently all funds for all road improvement must come from motor-vehicle and gasoline taxes, and that the new plan of distribution curtails the share of these funds controlled independently by the state. In taking the frank position that the road user is expected to finance the highways the Indiana legislators have also taken the logical position that road-tax money is exclusively restricted to road uses. Their attitude on distribution scarcely merits the same high commendation. Increased appropriation of state road-tax funds to county disposition, without increased control by the state highway department of its allotment and expenditure, does not promise success in developing coordinated state-road system improvement.

Still in the Woods

SUBSTANTIAL and sustained improvement in the commodity and security markets since the middle of July has provided a much brighter background for the business picture. So far, however, it is all background. Business itself is in no condition yet to discard its patched overalls nor fill its empty dinner pail. And to the unemployed engineer improved sentiment is largely a matter of hearsay. A job is the only way of improving his sentiment, which each day of unemployment brings to a new low. These dismal facts are recalled not at all from choice but from a feeling that they are in danger of being forgotten. Complacency toward the unemployment situation cannot be allowed to develop. Statistically business has not improved since it reached the depths in the early part of April. Basically a rejuvenation process was started on July 21 by the enactment of the Emergency Relief and Construction Act, which made R.F.C. funds available for public works. But in spite of all the gods of good fortune, conditions cannot be improved soon enough to alleviate widespread want this winter. Engineering unemployment will continue for a good many months to come. Local measures for unemployment relief must be planned or reinvigorated at once. We are not yet out of the woods.

Work for the Fall

PROGRESS in restoring earning power waits upon effective utilization of the Emergency Relief and Construction Act. Since its approval the construction section of the act has been going through the exasperatingly slow process of organizing for action. Now it is organized, and the Reconstruction Finance Corporation has given out its requirements as to information that must be supplied with all applications for loans for self-liquidating projects. These requirements (circular No. 3 of the R.F.C.) amplify some of the questions left open by the act itself. They have been prepared by the R.F.C. advisory engineering board and make it quite clear that that board will not approve projects of doubtful economic value or projects that have not been carefully worked out as to engineering, legal and financial details. This fact also is clear: a great deal of detailed preliminary work has to be done on any project before it will be in shape for the board to act. As a consequence, the preparation of such essential data must be attacked with skill and vigor if any R.F.C. loans are to be converted into jobs before winter sets in. Movements aimed at direct industrial employment, such as were discussed at Washington last week, may if widely directed prove helpful, but construction work under the emergency act still remains the greatest hope for early re-employment.

Studies of Building Sway

COMPILATION of facts on the structural action of high buildings was begun recently in San Francisco as part of a series of sway measurements. The elastic properties of such buildings are fundamental to their strength and stability, a fact which has been recognized vaguely for a good many years but has only slowly reached tangible acceptance. Vibration periods of buildings have a bearing not only on their resistance to earthquakes but also on their strength and livability under normal conditions. This latter fact has come to notice particularly through the construction of the exceptionally high buildings of recent years. Much remains obscure in the behavior of these superskyscrapers, and for this reason practical intuition has had to be depended on in the absence of definite knowledge of their structural behavior. But experience has repeatedly indicated that intuition is not always sufficiently sure to produce the desired results. As more is learned of the elastic properties of buildings we will acquire a new point of approach to the question of how building frames and shells behave,

and hence how they should be designed and proportioned. The data so far collected are few, but as fast as more become available we shall be making progress toward the solution of an important and difficult problem.

Two Essentials to Recovery

NEWEST of the proposals to initiate business recovery is a plan for concerted action in re-equipping and modernizing industry as a contribution to re-employment. The very purpose of the plan gives evidence of the now general recognition of the intimate dependence of reconstruction upon re-employment as the only source of new demand and new purchasing power. Accordingly, the plan itself invites enthusiastic support, but in proportion to the amount of employment that it is able to produce. A further element of value is its effect on the efficiency of the country's productive mechanism. In view of these potentialities it is important to observe that the great hopes centered in the plan may not be realized if its execution disregards certain weighty lessons of the recent past.

One vital fact to be reckoned with is the existing industrial overcapacity. Three years ago this fact confronted the business community in unmistakable seriousness. Our industries were seen to be wallowing in the heavy seas of hopeless effort to compete for a consumer market unable to support all the plants that had been built to serve it. The extent of the overcapacity has since become clearer during the continued decline of consumptive demand. Nearly every important industry has been found to be swelled to nearly twice its reasonable bulk. As is now well understood, a healthful state of production cannot exist while this condition survives.

Any general raising of industrial efficiency will obviously not make matters better. In fact, by enabling the same production to be attained with less plant and fewer workers it will, if anything, intensify present evils. Therefore the campaign of modernization and re-equipment, if it is to be successful, will need to be directed as much toward reduction of waste capacity as toward improvement in efficiency of plant and manpower. The methods to be applied to this end will no doubt be difficult to work out, but the same ability that is counted on to put under way the great campaign of modernization can equally solve the problem of controlling recklessly expanded capacity. Mere closing of plants is not sufficient; actual demolition of the least efficient or most obsolete units of an industry is essential to entitle any single industrial unit to the stimulated improvement that is being proposed. Without such correction of the existing condition of industrial overgrowth, stimulated modernization theatens to do more harm than good.

The second fact demanding consideration is industrial capitalization, and the questions that it presents are no less difficult than those involved in reduction of capacity. Much of the excess and obsolete capacity of our industries has not yet been written off the books, though its true value as reflected in earning power has long been zero or negative. But the mere existence of this surplus reacts on the earning power and hence on the value of the entire investment of the industry, even that in the most modern and efficient plants. The task of rehabilitation of industry's facilities includes not only regulation of capacity but also readjustment of capitalization and debts.

For example, it is urged that railway motive power requires modernization to the amount of hundreds of millions of dollars, and the argument is that new locomotives would pay for themselves within a very few years; but at the same time it is conceded that the old locomotives to be discarded under this program are still on the railroads' books in substantial sums. If new locomotives are to be bought, clearly the value of the old ones must at once be written off, or else the railroads will operate on a fictitious and inflated system of figures that will place an intolerable burden on both shipper and railroad. Many other industries exhibit substantially similar conditions. Their rehabilitation will be sound and constructive only as their capitalization is adjusted to the new conditions in a frank attitude of realism.

Industrial re-equipment thus presents complex problems. It requires more than a crude buy-now campaign and stimulated bank cooperation. Actual physical and financial readjustment of the nation's industrial machine are crucial elements in its success.

Raids on Road Funds Checked

TWO STATES have now turned back raids on gasoline-tax road funds by enacting sales taxes to provide doles for the destitute idle. Within the last two weeks Pennsylvania has followed the precedent set by Mississippi last April. If the reaction is as favorable as it has been in Mississippi, interests that have been fighting to preserve road-tax money for road improvement may find the example a powerful aid to their cause. By its moderate sales tax the Southern state has found it possible to distribute equitably the depression burden of general government and to continue road construction and its spread of self-respecting employment without appreciable disturbance of normal business.

The victory against diversion in Pennsylvania is perhaps suggestive in a larger way because of the organized battle waged by the Pennsylvania Construction Council, representing the unofficial roadbuilding interests of the state. Working with the state highway department and the governor, it rallied the sentiment for unabated highway improvement until the $12,000,000 tax-diversion bill was defeated—but only by the narrow margin of 96 to 90 votes.

In this close victory agencies that are resisting diversion have evidence of the strength of the forces that are seeking the easy tax money of the road user. These interests have not been disorganized by repulse. They are ready to renew the attack in Pennsylvania and in every state legislature that is bedeviled this winter by the need of relief to millions without work. If the attack is to be resisted, the defense must be organized not merely as concerted sentiment but as an active working body. The necessity cannot be exaggerated.

Roadbuilding interests can far better see federal-aid money lost than see loss of the right of the highways to the money that travelers pay the states for road service. In the logic of events the states must expect that ultimately federal contributions will cease. They will cease as soon as federal legislators come to realize that they are giving federal road money only to replace state road money diverted to other uses. Motor-vehicle tax diversion must be checked if highway construction is to continue to enjoy cheerful payment of gasoline and vehicle taxes by the motor-using public. It can be checked only by organized effort.

NEWS OF THE WEEK

Golden Gate Bridge Bonds Put on the Market

Calls for bids on the first block of $6,000,000 of bonds for the projected bridge over Golden Gate at San Francisco was made on Aug. 31 by the Golden Gate Bridge and Highway District. The district has been authorized to issue a total of $35,000,000 of bonds.

As noted last week, all legal obstacles to the sale of the bonds have been removed and the district expects to get the project under way soon. It is reported to have filed an application for a loan with the Reconstruction Finance Corp.

River Control Work Not Affected By 10 Per Cent Cost Cut

Work of the War Department upon rivers and harbors and on flood control will not be affected by the 10 per cent cost cut required by the economy act, in the opinion of the engineers of the War Department. Engineers of the War Department point out that Congress in its authorization of such work sets out the work to be done rather than a maximum amount to be spent, as in the case of public buildings. The only exception to this is the Mississippi River flood control work where Congress set the limit of $325,000,000 as the amount to be spent. However, as half the work has been completed or contracted for, the army engineers believe that that work will be exempted from the provisions of the economy act in view of the fact that the government has already obligated itself to complete the project in its present form. A 10 per cent cut now would seriously affect the work that remains to be done.

Preliminary Plans Made for Highway and Building Congress

A committee to handle the details of arrangements for the Highway and Building Congress to be held in Detroit Jan. 16 was selected by representatives of interested organizations which met in Washington Aug. 25. The organization will be known as the general committee of the Highway and Building Congress. Charles Upham, engineering director of the American Road Builders' Association, was selected as chairman of the committee. The other members of the committee will consist of the president and the secretary of the following organizations: Construction League of the United States; Associated General Contractors of America; Truck Association Executives of America; The Asphalt Institute; National Crushed Stone Association; National Paving Brick Association; National Ready Mixed Concrete Association; National Sand and Gravel Association; Portland Cement Association, and the Wire Reinforcement Institute.

The committee decided that the program should deal principally with questions of taxation, the disposition of tax funds and the construction phases of federal relief legislation.

Rigid Rules Set For Construction Loans from R.F.C.

REQUIREMENTS to be met by applicants for loans from the Reconstruction Finance Corp. under the provisions of the Emergency Relief and Construction Act of 1932 are contained in circular No. 3 of the Reconstruction Finance Corp. which was made public on Monday. The requirements set forth in the circular apply to all applications for loans for self-liquidating projects. They have been prepared with the advice of the board of engineers recently appointed to aid the R.F.C. directors in passing upon applications for loans for self-liquidating projects. (*ENR*, Aug. 11, p. 176.)

Type of application

No application will be considered by the R.F.C. unless (a) the project is shown to be "self-liquidating," (b) the proposed loan is shown to be fully and adequately secured, and (c) complete information is supplied as to all phases of the project.

The Corporation is authorized under the relief act to make loans to states, municipalities, and political subdivisions of states, public agencies of states, of municipalities and of political subdivisons of states, public corporations, boards and commissions, and public municipal instrumentalities of one or more states. It may also make loans to regulated housing corporations for privately-owned projects devoted to public use, loans for privately-owned projects devoted to public use, loans for protection and development of forests, and loans for publicly-owned bridges supported in part by taxation.

Loans to housing corporations

On the subject of loans to housing corporations the circular points out that no loan can be made unless the applicant corporation is regulated by law as to rents, charges, capital structure, rate of return and area and methods of operation. Hence, prospective borrowers must be able to show that such laws exist in the place where the project is to be erected. The New York State housing law is cited for the benefit of those who must obtain legislation before making application for a loan.

Under privately-owned projects devoted to public use, the board lists the construction, replacement or improvement of bridges, tunnels, docks, viaducts, waterworks, canals, and markets.

Generally, loans made by the R.F.C. must be made for periods not exceeding ten years, but loans to states, municipalities, etc., may be made for longer periods in the judgment of the directors and the directors may purchase the bonds of publicly-owned bridge corporations irrespective of the date of maturity of such bonds.

Citing the definition of self-liquidating projects given in the relief act (*ENR*, July 21, p. 88), the circular states, "This provision of the act clearly imposes the requirement that in order to be eligible for a loan, the project must be one which will produce sufficient revenue to make it self-supporting and to return its construction cost within a reasonable period. *Taxation* is expressly excluded as a source of revenue for such purposes." The circular states further that in case of doubt as to whether the revenues of a project may not be derived from taxation (for example, where such revenues are derived from assessments imposed substantially in proportion to the use of the facilities afforded by the project), it is suggested that applicants before preparing any formal application furnish the Reconstruction Finance Corp. proof that such revenues do not constitute taxation.

Security of loans

The circular states that the relief act expressly requires that all loans made by the corporation shall be fully and adequately secured, that in addition to stating the amount of the loan requested the applicant should specifically state what additional cash or property will be invested in the enterprise and what security, if any, will be given therefor. No loans will be made upon foreign securities.

The labor requirements of the relief act as to the maximum 30-hour week, preference for ex-service men and elimination of convict labor, are cited in the circular.

Form of application

The manner in which applications are to be made is outlined in great detail in the R.F.C. circular. Applications must include a summarized statement of the total cost of the project, including cost of construction, land, right-of-way and other costs. The amount of the loan applied for must be stated as well as the time of repayment. Applicant also must give the

Work on Highway Contracts in Louisiana Ordered Resumed

Contractors holding unfinished projects of the Louisiana Highway Commission have received orders from Chairman A. P. Tugwell to resume work on a basis of 30 per cent cash and 70 per cent certificates in payment or else forfeit their contracts.

Receipt of such an order is reported to have resulted in a dispute between the commission and H. Pratt Farnsworth, holder of an unfinished contract for constructing a swing steel span bridge across the Vermilion River, near Lafayette, La. The original contract was for approximately $56,000, under which the work is about 90 per cent complete, and $26,000 lacking to effect full payment. Mr. Farnsworth stated he had purchased $15,000 worth of new equipment which was used on the bridge construction and has continued maintenance on the 90 per cent completed structure to prevent its being damaged. The work was started in August, 1931, payments from the Louisiana Highway Commission stopped in October, and work suspended just before Christmas.

nature and sources of revenue and the time that will elapse after funds are made available before (a) work can be commenced, (b) project will be completed, (c) project will become fully self-supporting, and (d) construction costs will be fully returned from net revenues. Detail statements also are required as to all items of cost, fees, interest charges, insurance and taxes.

An estimate of the average number of men directly employed at 30 hours per week and the cost of construction materials for each quarterly period during construction is required.

The applicant is required to make a statement as to all objections that are known to have been made in respect to the project together with the names and addresses of objectors.

Financing

A full statement of plans for financing a project, including all additional future financing necessary or contemplated, is required, as is a statement as to proposed terms of the loan applied for, type of obligation offered, interest rate, sinking fund provision, etc. The applicant also is required to make a full statement as to prior efforts to finance all or a substantial part of the project through sources other than the R.F.C., together with names of parties thereto and terms offered.

Sources of revenue

The nature and source of expected revenues must be given, together with a schedule of proposed charges and a statement as to whether requisite approval for the charges has been received. Existing and prospective enterprises with which the project might compete, together with a schedule of their charges, must be included.

Supporting data

The supporting data must be given in detail to show estimated gross revenues, operating and administrative expenses, depreciation and taxes, estimated net income, net profit for each year and sinking fund and principal requirements. Private corporations are required to submit financial statements for a number of years back and public bodies are required to produce certified statements as to assessed valuation of taxable and real property, basis of assessment, amount of taxes levied, rate and amount uncollected for the last three fiscal years.

Financial relations

Complete information as to the applicant's credit relations with banks and other financial institutions and the financial history of any similar project if undertaken by it is required. Legal opinion as to the applicant's right to undertake the project and as to the validity of the securities offered must be included. All constitutional provisions, statutes, and so forth, which bear on the project, must be cited in full.

Engineers and architects

Applicants for loans are required to give the name of the architects and engineers who prepared the plans for their applications or who acted as consultants.

Six copies of applications must be submitted and three of them must be accompanied by copies of all supporting data, including plans, detailed estimates of cost and legal opinions.

Brief News

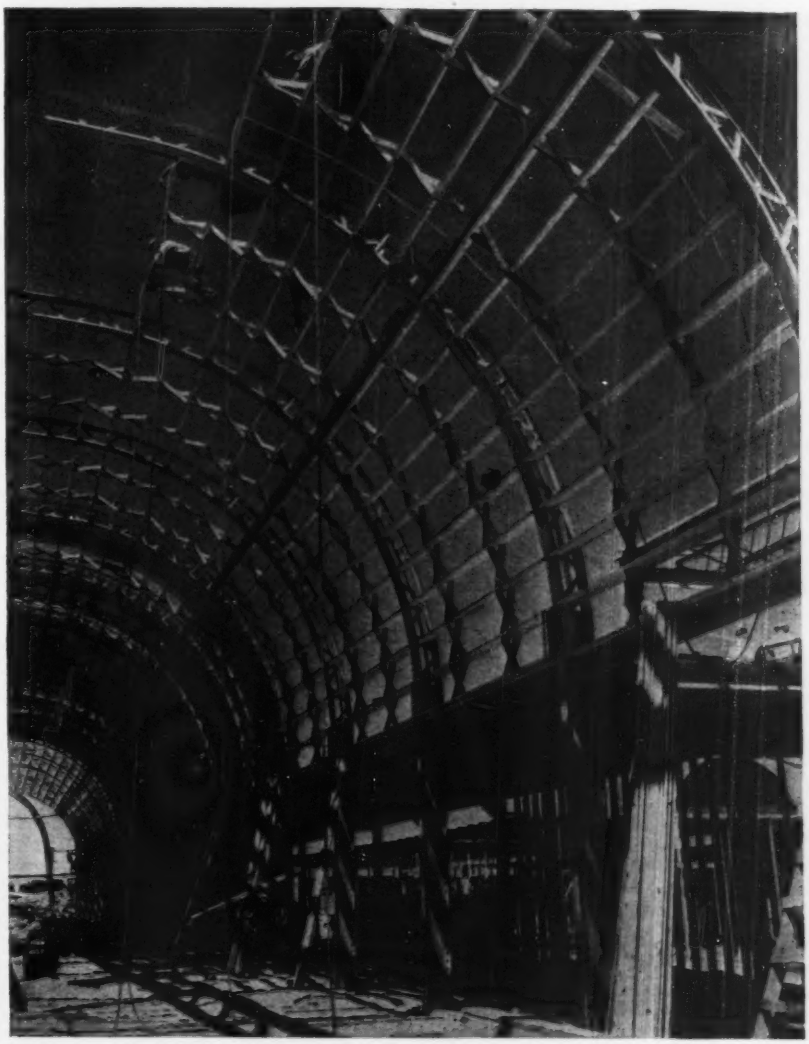
THE STATE BRIDGE COMMISSION of West Virginia was abolished by a bill passed over the governor's veto at the recent special session of the state legislature. The duties of the bridge commission have been transferred to the State Road Commission.

FIELD WORK HAS BEEN STARTED by the Coast and Geodetic Survey on a line of first-order levels running from Port Jervis, N. Y., through Milford and Dingmans Ferry to Bushkill, Pa., and then through East Stroudsburg, Portland, Bangor, Easton and Allentown to Reading, Pa.

ABANDONMENT OF 77 MILES of railway between Cliffside and Irvine, Ky., by the Louisville & Nashville R.R. has been authorized by the Interstate Commerce Commission. A part of the line was built to reach distilleries, now out of operation, and part to reach forests which have since been depleted of all commercial lumber.

AN EXPLOSION IN A SEWER on St. Lawrence Boulevard in Montreal on Aug. 23 lifted the crown of a 6-ft. brick sewer for a distance of about 4,000 ft. and damaged 700 ft. of 5-ft. sewer. Considerable damage was done to the pavement of the boulevard and a gas main was burst and set on fire. The cause of the explosion is not known but is believed to have been gas from refuse discharged by paint factories and garages.

NATIVE LABOR must be given preference on the construction of the new United States post office at Portland, Maine, according to a ruling of the Comptroller General. In his ruling the comptroller stated that while such labor preference is not stipulated generally for federal projects, except for those specifically authorized under the emergency construction and relief act, it had been stipulated in the case of Hoover Dam and appears a reasonable requirement in the case of a project located close to the international border, as in the case of the new post office at Portland.



AGRICULTURAL BUILDING AT WORLD'S FAIR TAKES FORM

Rapid progress is being made on the Agricultural Building for the Century of Progress Exposition to be held in Chicago next summer. The building is 628 ft. long and 108 ft. wide with three wings extending toward Lake Michigan. Its main feature will be the arched roof shown under construction here. The ribs are of riveted steel. Wooden framing for the roof is secured between the main ribs.

Sanitary Works and Toll Bridges for R.F.C. Loans

APPLICATIONS for loans on self-liquidating projects continue to be filed with the Reconstruction Finance Corp. and consideration is being given in many other cases to preparing such applications.

A loan of $2,000,000 has been asked to build a toll bridge across the Mississippi River at Helena, Ark. The plans for the bridge have been in the making for the past three years but have failed to materialize because of lack of financing. Under the plan announced now bridge bonds will be put up as collateral for a loan at 3 per cent interest. Tolls over the bridge would be fixed by the War Department. After the cost of the bridge is paid for, it would become the property jointly of the states of Arkansas and Mississippi and have the tolls removed.

A preliminary application has been filed for a loan of $850,000 for the construction of a toll bridge across the St. Lawrence river at Collins Landing, New York. The sum of $150,000 more is requested for road construction on Wells Island.

The Kentucky highway commission has authorized an application to the R.F.C. for a loan of $1,500,000 to construct a bridge over the Ohio river at Owensboro, Ky. The state is to request the highway commission of Indiana to cooperate financially in the project.

Representatives of Cairo, Ill., and Wickliffe, Ky., have urged the Kentucky state highway commission to take steps toward the construction of a toll bridge over the Ohio River at Cairo.

A plan for borrowing $3,000,000 from the R.F.C. for the construction of four toll bridges on the Oregon Coast Highway is being advocated by one of the state highway commissioners. According to C. B. McCullough, state bridge engineer, construction of the bridges would eliminate the annual expenditure of $110,000 for ferries now operating sixteen hours a day. According to the plan ferries would be replaced by bridges at Newport, Waldport, Florence and Reedsport.

Funds are being sought by the city of The Dalles, Ore., for construction of a bridge across the Columbia River. It is believed that the city could authorize $200,000 of general-obligation bonds and obtain the required balance of $500,000 from the R.F.C. Astoria, Ore., is also considering applying for a loan to construct a bridge across the Columbia River. The structure would cost about $3,000,000. At this point the river is 5 miles wide.

The city council of Canton, Ohio, has been asked by the city solicitor to consider making application to the R.F.C. for a loan of $350,000 to be used in the development of the northeast water field, an area recently acquired, as an additional water source for the city. It has been announced that work could proceed immediately in sinking wells, laying additional mains, constructing a reservoir and installing equipment.

North Carolina will use none of the money it may be allotted from the $300,000,000 federal fund for relief distribution as a straight dole. Governor Gardner has announced that the money will be spent probably through the state highway department for labor on the highways where hand labor can be most utilized.

In Alabama the towns of Sylacauga, Anniston, Talladega, Childersburg and Heflin are planning to extend their waterworks systems through the assistance of R.F.C. funds. Talladega is also contemplating building a sewerage system and a municipal swimming pool. Jasper has applied for a loan of $50,000 to be used for the construction of a sewage treatment plant.

Hopkinsville, Ky., is considering applying for a loan of $320,000 for the construction of a sewerage system and sewage treatment plant.

Fort Worth, Texas, is planning to request a loan of $600,000 to finance grade crossing elimination work. Approval of the voters of the city has already been given to a bond issue for the project.

At the special session of the Ohio legislature, which is to meet early in September, effort will be made to enact legislation that would regulate private corporations engaged in building homes for persons with small incomes. The legislation would permit Ohio cities to obtain loans from the R.F.C. for slum elimination and improved housing.

The Duluth Steam Heating Corporation has applied to the R.F.C. for a loan of $1,000,000 to complete the construction of its central heating plant now about half finished.

The Richmond-San Rafael Ferry Co. of San Francisco is planning to request a loan to finance construction of a $10,000,000 toll bridge to be known as the Richmond San Rafael Toll Bridge.

Other applications have been noted previously in these columns.

NEW RAILWAY LINE OPERATED UNDER VANCOUVER

The Canadian Pacific Railway recently opened a tunnel 6,140 ft. long under the business section of Vancouver, B. C., to eliminate its railway line at grade through the city with many level crossings. The eastern portal of the tunnel is on False Creek near the railroad company's freight yard from whence it swings under a recreation park past the armory and straightens out to follow Dunsmuir St. in a westerly direction through the city. At many points sewers and other underground facilities had to be supported during the tunnel construction.

The tunnel was built for the railway by the Northern Construction Co. with N. E. Lambert as engineer in charge. F. Lee is district engineer for the railway company.

Hand Labor Raises Pavement Cost in Montreal

Asphalt pavement costs amounting to $35 per sq.yd. were reported to the city council of Montreal recently as the result of efforts to spread employment by doing all city work by hand labor. On a strip of pavement 30 ft. wide and 104 ft. long estimated to cost $13,300, the actual cost ran to over $25,000.

F. E. Lamphere Named Executive of R.F.C. Advisory Board

F. E. Lamphere, former construction manager, United Engineers & Constructors, has been appointed engineering executive to the engineering advisory board of the Reconstruction Finance Corp. The engineering board, which was named early in August, consists of Charles D. Marx, Major General Lytle Brown, John F. Coleman, John H. Gregory, and John Lyle Harrington. Mr. Lamphere will be executive head of the staff of engineering examiners appointed by the board to assist it in analyzing the applications for loans submitted for its approval. From 1917 to 1920 he served as a colonel in the construction division of the Quartermaster Corps and was construction engineer of Camp Taylor, the Newark port terminal and the port terminal at Charleston, S. C. For two years following his army service he was on the consulting board of the American Sugar Refining Co. and in this capacity was engaged in the erection of the company's refinery at Baltimore. Following this Mr. Lamphere became affiliated with the U.G.I. Contracting Co., and the United Engineers & Constructors.

New Transit Plans for Buffalo

A comprehensive transit plan, involving a great deal of new construction, has just been filed with the Common Council of Buffalo, N. Y., by the International Railway Corporation. The plan was in response to demands by the council, for some idea as to the future operations of the company in Buffalo. How soon it will be put in effect is another question. The company already started some small construction work as a part of the plan.

Waterworks System of Dallas To Be Expanded

Next year the city of Dallas, Texas, plans to begin a 6-year program for the improvement of its waterworks system. The program will cost ultimately $1,764,000. It will include additions to the pumping and purification plants and to the distributing system. The work is to be financed with surplus revenues from the sale of water rather than by bond issues.

The $200,000 addition to the pumping and purification plant is to be started next year. It will increase the plant's daily capacity to 60,000,000 gallons. The maximum capacity of the plant now is 40,000,000.

Baltimore Officials Consider Wider Use of 30-Hour Week

Baltimore municipal officials and members of the Maryland State Roads Commission are considering the advisability of adopting the 30-hour week as a means of helping speed economic recovery. The subject has been placed before them by the Baltimore Federation of Labor, headed by Henry F. Broening.

Mayor Howard W. Jackson, of Baltimore, and Bernard L. Crozier, the chief engineer, will hold a conference on the suggestion in regard to future construction work to be carried on by the city. Members of the State Roads Commission also promised to give the suggestion consideration.

Sale of Bonds Speeds Work on Pine Canyon Dam

The city of Pasadena, Calif., on Aug. 24 sold $992,000 in bonds of an issue of $10,000,000 voted for construction of the Pine Canyon water storage project. The bonds sold, bearing interest at 4¼ per cent, brought a premium of $17,539 from Dean Witter & Co., the successful bidder. Three financial houses bid for the issue, which was the first to be offered by the city. Out of the original $10,000,000 in water bonds voted, only $6,500,000 will be issued for the Pine Canyon project. Savings account for a cut of more than $3,000,000 in the original estimates. The savings are due to lower cost of materials and to modification of the dam plans.

Petition for an injunction to restrain the city of Pasadena, Calif., from building a dam at the Pine Canyon site in San Gabriel Canyon has been filed in the Los Angeles county superior court by a number of property owners in the area who assert that if the project is carried out they will be deprived of their riparian rights.

Township Roads in Indiana Pass to County Control

THE special session of the Indiana legislature, called recently to reduce taxes, before its adjournment passed an act transferring jurisdiction of all township roads from the township trustees to the board of county commissioners. The act becomes effective Sept. 1. Another bill provides a 5-year moratorium on the issuance of county road bonds and another act diverts to counties, cities and incorporated towns half of the net proceeds of fees from the registration of motor vehicles. The other half goes to the state highway commission. Four-fifths of the sum assigned to the towns, cities and counties is divided among counties and one-fifth goes to the cities and towns, except in the case of the county in which Indianapolis is situated where the city gets half the funds for maintenance and repair work. The act relating to motor fuel taxes was amended. All money so received now goes to road construction of some sort.

The legislature empowers the state highway commission, before awarding contracts, to fix the minimum wage which is paid by the contractor. This provision of the act was made effective in the call for bids opened Aug. 23 when the director of the highway commission fixed 30 cents an hour as the minimum wage scale for laborers in the southern part of the state and 35 cents an hour in the northern half.

Another act amends the provision of the state highway commission law which provides that where a street in an incorporated town or city is improved and the expense is greater per mile than the average for such road outside the corporate limits, the extra expense is to be paid by the city or town to the highway fund. The amendment provides that to obtain funds for this extra expense the common council or board of town trustees shall assess 75 per cent of the extra expense as special benefits to all taxable property and 25 per cent shall be assessed as benefits against the abutting property.

Hoover Dam Notes

An unusually low stage is prevailing in the Colorado River. On Aug. 20 the discharge at Boulder Dam fell to 7,300 sec.-ft. The maximum temperature in the canyon during the week ended Aug. 20 was on Aug. 17, when the thermometer touched 113 deg. The maximum temperature in Boulder City was on Aug. 19, when 104 deg. were registered. The minimum temperatures were on Aug. 16, when a mark of 78 deg. was registered in the canyon and 75 deg. in the town.

* * *

An unusual accident on Aug. 18 resulted in the complete failure of the electrical supply on the project for a period of ten minutes. It was caused by an airplane that crashed near Riverside, Calif., and carried down the transmission line.

* * *

As further evidence that employees of Six Companies, Inc., are not being compelled to trade at the company commissary through the payment of scrip, Elwood Mead, Commissioner of Reclamation, has given out figures to show that 91 per cent of the wages paid at the dam are paid in cash. The 9 per cent paid in scrip is in the form of advance payments to men needing supplies.

The Department of the Interior has asked members of the Senate Committee on Irrigation and Reclamation to include Hoover Dam in their trip to study reclamation projects in California in order that they may get first-hand information as to labor conditions at the dam.

* * *

The contract for 30 three-room frame residences for government employees was completed Aug. 18. The dwellings were occupied immediately thereafter. Work on the school house is 70 per cent complete. The new frame dormitory is 60 per cent complete.

* * *

Low pressure grouting has been started in tunnel No. 3. At the Arizona gravel deposit 1,051 cars of aggregates were loaded out. The mixing plant manufactured 15,136 cubic yards of concrete.

Personal Notes

CRESWELL GARLINGTON, Major, Corps of Engineers, U. S. Army, has been transferred from his position as assistant to the division engineer, South Atlantic Division at Norfolk, Va., to be district engineer at Savannah, Ga.

J. W. JOURDAN, chief designing engineer, San Joaquin Light & Power Corp., Fresno, Calif., has accepted the position of assistant professor of civil engineering at the New Mexico State College of Agriculture and Mechanical Arts, Mesilla Park, N. M.

R. W. SIMPSON, assistant general manager, Atlantic Region, Canadian National Railways, Moncton, N. B., has been retired after 43 years of service, chiefly in the engineering department of the Canadian National Railways and its predecessor the Intercolonial Ry.

Obituary

GEORGE E. BABCOCK, engineer, finance department, City of New York, until his retirement two years ago, died at his home at Greenwich, Conn., on Aug. 25, aged 78 years.

W. E. HOTCHKISS, formerly one of the engineers on the Panama Canal during the time of its construction, died at his home at Courtland, Alabama, on Aug. 22, aged 77 years.

WILLIAM C. COLES, 48 years old, a valuation engineer in the employ of the Baltimore & Ohio Railroad, Baltimore, killed himself on August 25 by jumping from a window on the eleventh floor of the Baltimore & Ohio Building.

RODERICK MACLENNAN, engineer of the provincial highway department of Ontario since 1914, died at Toronto, Ont., in his 63d year on Aug. 25. Mr. MacLennan was a graduate of the University of To-

ronto and for a number of years after graduation was employed on survey work for the Canadian Pacific Ry. in the West and later on railway construction in Mexico.

LLOYD E. STRUM, president, Strum & Dillard, railroad contractors, died at his home in Columbus, Ohio, on Aug. 26.

OSCAR E. HINDS, for many years active in engineeirng work in northern New York, died at his home in Watertown on August 26, age 83 years. For a time he was associated with former state engineer Edwin A. Bond, under the firm name of Hinds & Bond.

JOHN M. FARLEY, formerly a member of the civil engineering firm of Carpenter & Farley, died at his home in White Plains, N. Y., on August 26. He was 69 years old. Mr. Farley received his civil engineering degree from Rutgers College in 1889 and after a few years of railway work and work on the New York State canals he established an office as a civil engineer in White Plains, N. Y.

FREDERICK W. ALBERT, assistant chief, engineering division, Edgewood Arsenal, Edgewood, Md., died at Washington, D. C., on August 23. From 1924 to 1928 Mr. Albert was in charge of construction of the extension of the water works system of Knoxville, Tenn. He was a graduate of George Washington University in 1906 and was an engineer in the War Department from graduation until the outbreak of the World War when he was commissioned and ultimately was sent to France where he had charge of sanitary engineering work in base section No. 5.

GEORGE M. WISNER, consulting engineer to the Sanitary District of Chicago, died at his home there on August 26, in the 62nd year of his age. Mr. Wisner was a native of Detroit and a graduate of the University of Michigan in the class of 1892. Upon graduation he went immediately to the sanitary district of Chicago and was with the district continuously until his retirement to enter into private practice in 1920. He was made chief engineer in 1907. In recent years he has acted as consultant to the district and to the city's subway commission. Despite the almost complete loss of his sight he has taken an active interest in his work.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual convention, Washington, D. C., Sept. 26-28.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, White Sulphur Springs, W. Va., Oct. 11-14 (tentative).

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., Oct. 24-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Atlantic City, N. J., Oct. 5-8.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, New Orleans, La., Nov. 14-18.

AMERICAN WELDING SOCIETY, fall meeting, Oct. 3-7, Buffalo, N. Y.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9. The ASSOCIATION OF ASPHALT PAVING TECHNOLOGISTS will meet in conjunction with the paving conference.

INTERNATIONAL CITY MANAGERS ASSOCIATION and GOVERNMENTAL RESEARCH ASSOCIATION will hold a joint annual conference at Cincinnati, Ohio, on October 24 to 26.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, annual meeting, Hot Springs, Ark., Nov. 15-18.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, New York City, Sept. 29-Oct. 1.

NATIONAL SAFETY COUNCIL, annual congress, Washington, D. C., Oct. 3-7.

NEW ENGLAND WATER WORKS ASSOCIATION, annual meeting, Springfield, Mass., September 27-30.

MISSOURI WATER & SEWERAGE CONFERENCE will hold its eighth annual meeting at Sedalia, Mo., on Oct. 13-14. Secretary, Herbert Bosch, State Board of Health, Jefferson City, Mo.

Engineering Contracts and Capital

Heavy engineering construction contracts reported for the past week total $18,058,000, an increase over the previous two weeks, but more than $2,000,000 below the August weekly average of $20,351,000. Federal awards amounted to $4,604,000, which is above the August average. Private construction totaled $1,506,000, the smallest weekly figure since early last February. Large contracts let during the week include Mississippi River levee work aggregating $1,326,000 and state highway contracts in Montana amounting to over one million dollars.

No private bond issues for construction purposes were reported during the week. Public issues of new capital for construction amounted to only $6,000,000. Illinois sold $1,000,000 of waterways bonds.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly Average Sept., 1931	Weekly Average Aug., 1932	Week Sept. 1, 1932
Federal government	$10,409	$4,175	$4,604
State and municipal	21,880	12,334	11,948
Total public	$32,289	$16,509	$16,552
Total private	11,950	3,842	1,506
Week's total	$44,239	$20,351	$18,058
Cumulative, Jan. 1 to date:			
1931 construction			$1,823,549
1932			818,265

Decrease, 55 per cent.

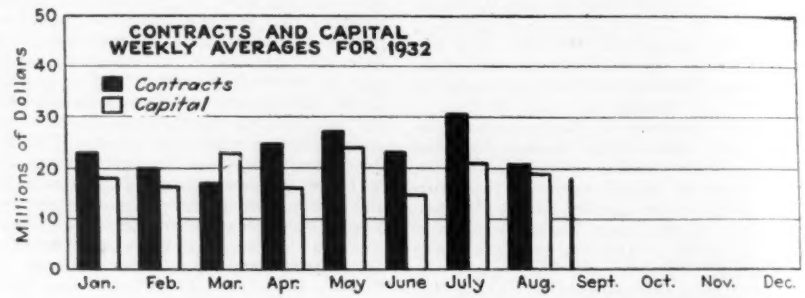
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

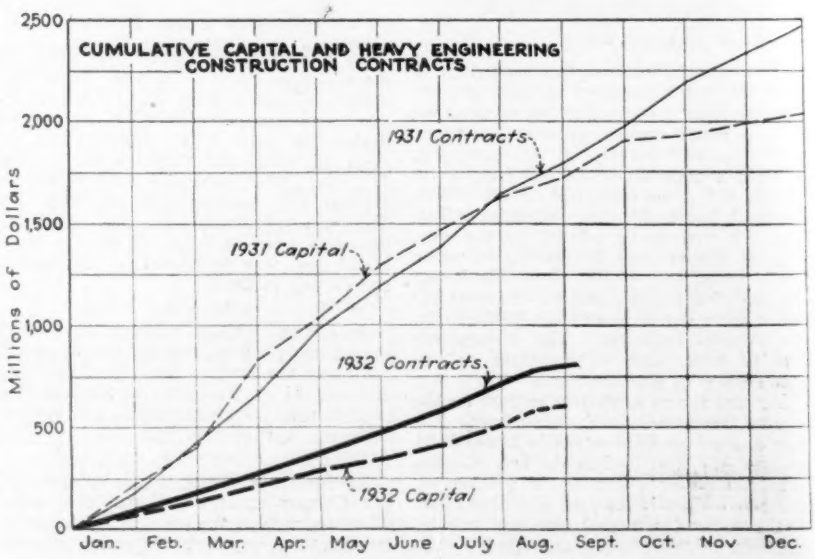
	Weekly Average Aug., 1931	Weekly Average Aug., 1932	Week Aug. 27, 1932
Total private and public	$21,000	$19,000	$6,000
Cumulative, Jan. 1 to date:			
1931 new capital			$1,715,000
1932 new capital			594,000

Decrease, 65 per cent.

ENR Cost and Volume Index

Cost		Volume	
September, 1932	157.96	**August, 1932**	111
August, 1932	156.80	July, 1932	166
September, 1931	171.40	August, 1932	187
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 Average	100.00		

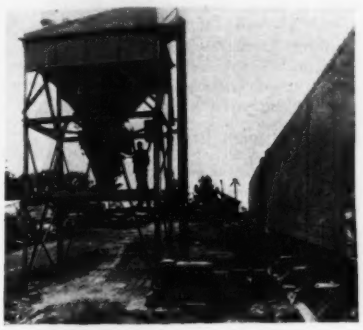




Construction Equipment and Materials

Screw Elevator for Bulk Cement

Sprout, Waldron & Co., Inc., Muncy, Pa., announce a new self-contained vertical-screw elevator for handling bulk cement. The new conveyor consists of a combination of horizontal and vertical screws in a dust-tight weatherproof casing arranged to receive material from ordinary box or



Screw conveyor for cement by Sprout, Waldron & Co.

hopper cars and to elevate it to storage bins. Both horizontal and vertical screws are built with heavy-gage flights. Casings are electrically welded seamless pipes. The machine is driven by either gasoline engine or electric motor and operates to a height of 45 ft.

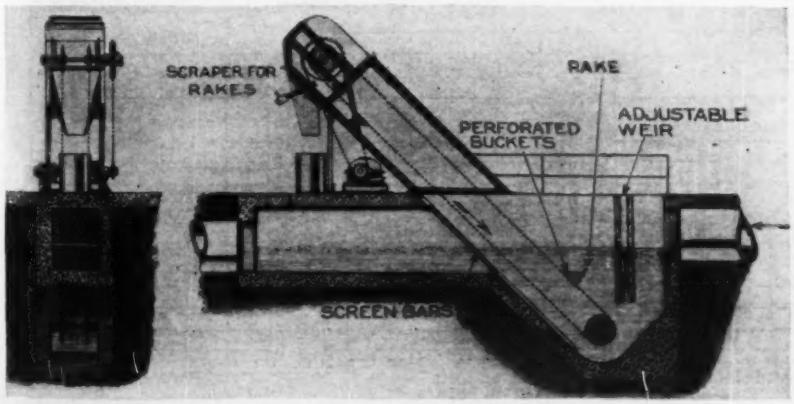
The equipment is also suitable for handling such products as sodium nitrate, lime, cocoa, grain, flour and other materials.

Grit Chamber and Screen Combined in One Unit

A combined bar screen and grit chamber, designed for use at medium and small sewage-treament plants, is being introduced by the Link-Belt Co., Chicago, Ill. The maker states that the equipment is especially adapted to plants where the cost of separate mechanically cleaned units might be prohibitive.

The main elements of the equipment consist of a hopper, a bar screen with 1-in. openings, and a bucket elevator that removes the grit from the hopper and cleans the screen. Regulation of the currents through the hopper is accomplished by two baffleplates near the influent end, one adjustable downward and the other upward, to permit settling of the grit and prevent settling of the organic matter. The upper baffle allows part of the flow to pass over it. The lips of the elevator buckets are provided with rake teeth, which engage with and clean the screen bars on their downward travel. The buckets are perforated, permitting the water to drain out while they carry the grit and other accumulations to discharge into a suitable container or trough for removal.

Bar screen and grit chamber by Link-Belt.



Business Notes

COLUMBUS-McKINNON CHAIN CORP. announces the removal of their fire-welding operations from Columbus, Ohio, to Tonawanda, N. Y. The Tonawanda plant is equipped to manufacture all sizes and grades of fire-welded chain, formerly made in Columbus.

THE STIBLOY PRODUCTS CO., INC., with principal offices in the Koppers Building, Pittsburgh, Pa., has taken over the assets of Liquid Metal Products, Inc., Chicago, producers and distributors, under the Arent patent, of Stibloy—a liquid metal compound for primary coatings to hold paint, enamel, and lacquer.

SIMPLEX WIRE & CABLE CO. announces the opening of a branch office in Detroit under the management of Herman C. Joos. The new office is located at 321 West Lafayette Boulevard.

SHELL EASTERN PETROLEUM PRODUCTS, INC., New York City, has made known the completion of a new factory at Boston, Mass., for the manufacture of Colas, an asphalt emulsion for low-cost road construction.

DIESEL ENGINE MANUFATURERS' ASSOCIATION has announced that at a recent meeting H. Birchard Taylor of Philadelphia was elected president, succeeding George W. Codrington, of the Winton Engine Co., Cleveland, who was elected chairman of the board. E. T. Fishwick of the Worthington Pump and Machinery Corp. continues as chairman of the executive committee. The Diesel Engine Manufacturers' Association was organized in 1928 and has since been active in promoting trade standards in the Diesel industry and in gathering Diesel engine statistics. At the time of his election to the presidency of the association, Mr. Taylor was president of the Cramp-Morris Industrials, Inc. He is also a consulting engineer to the Baldwin locomotive works.

New Equipment in Brief

Diesel Exhaust Silencer—The Maxim Silencer Co. announces a new exhaust washing silencer for diesel engines, known as Model EW. It is built of cast iron throughout. Only a moderate amount of water is required, the cooling circulation being sufficient. The silencer is designed to quench all sparks, wash the exhaust clean of carbon and dirt and to quiet the exhaust noise without imposing back pressure affecting the operating efficiency of the engine.

Welding Nipples—The Midwest Piping & Supply Co. Inc., St. Louis, Mo., has placed on the market a line of shaped welding nipples that eliminate templets when saddling one pipe upon another. The nipple is placed in position before the opening is cut in the pipe upon which it is to be saddled; the correct opening is then traced from the nipple contact line. The nipples are made from standard weight and extra heavy wrought-steel pipe and genuine wrought-iron pipe. Sizes are from 1¼ to 12 in. Angles of 45 and 90 deg. are standard.

Power Adapter for Pipe Threader—A new power adapter for threading pipe, known as the No. 17 Beaver pipe threader, is announced by the Borden Co., Warren, Ohio. The adapter is a worm-driven die stock using interchangeable die heads to thread pipes of ½- to 2-in. diameter. It is operated by a ¾-in. heavy-duty electric drill. A compressed-air drill may be used if desired.

New Publications

Rebuilt Equipment—"Construction, Industrial & Material-Handling Equipment Stock List No. 134," issued by the Equipment Corp. of America, 1150 S. Washtenaw Ave., Chicago, Ill., lists "E.C.A. Rebuilt" equipment available from their Chicago, Pittsburgh and Philadelphia plants.

Road Machinery—The Gallon Iron Works Mfg. Co., Galion, Ohio, in catalogs Nos. 125, 130 and 135 describes the construction and operating features of its No. 14 heavy-duty leaning-wheel grader, motor patrol graders and road maintainers, respectively.

Early-Strength Cement — Waldemar Kaempffert, scientific editor of the New York *Times*, has prepared for the International Cement Corp. an attractive illustrated booklet of 30 pages entitled, "New Profits from Idle Days." The book tells in popular fashion the history of the use of cement. It begins with a brief interesting account of the construction of the great Egyptian pyramid at a time when cement was not used, and concludes with an account of the uses and characteristics of Incor high-early-strength cement. A great deal of attention is paid to the economies resulting from the use of a cement that attains a high degree of strength in a short time.

Electric Switches—Westinghouse Electric & Manufacturing Co. has recently issued catalog 2246, containing 76 pages of factual information regarding load centers, panel boards, switchboards and industrial breakers. All of the equipment described use De-Ion circuit breakers instead of fuses.

Gypsum Lath—"Facts About Gypsum Lath" is the title of a recent publication of the Gypsum Association, 211 West Wacker Drive, Chicago, Ill. This booklet explains the uses of gypsum lath and discuses the advantages its affords to home builders and prospective home owners. The booklet contains eight illustrated pages.

Auto Trucks—The International Harvester Co., of America, Chicago, Ill., has issued a 32-page illustrated pamphlet describing International trucks for contractors, excavators and road builders. It is richly illustrated with photographs of International trucks used in a wide variety of services.

Business Side of Construction

August Construction Volume Lowest of Any Month Since Last March

AFTER RESISTING the usual early summer slump, the volume of construction yielded to the customary seasonal trend in August and dropped to an average of $20,400,000 per week for heavy engineering construction contracts reported by *ENR*, the lowest weekly average since last March, when weekly contracts averaged $16,000,000. The total reported for August (four weeks) was $81,634,000. The weekly average of contracts reported for the previous three months, in millions of dollars, were: July, 30.1; June, 23.7; and May, 26.9. Public construction contracts in August dropped $4,500,000 weekly from the July average of $23,100,000. Private construction for the past month was little more than half of the July volume, averaging $3,800,000 per week. Highway contracts in August represented the only class of construction that kept pace with the July volume, averaging $7,500,000 per week. Public building awards were but half of the July volume, while federal government awards amounted to only $4,200,000 a week, about one-third of the previous months' volume. The July weekly average was maintained for all classes the first two weeks of August, but only highway contracts held up during the last two weeks of the month.

Geographical distribution of heavy engineering construction contracts reported during August (four weeks) in thousands of dollars. Federal contracts are included in regular classifications, but are also given separately as a matter of record. Below are shown weekly average contract awards, in millions of dollars, for various classes of work and for different sections of the country.

Cost index rises again

For the third successive month the *ENR* cost index has shown an increase over the previous month, the September index standing at 157.96, as compared with the August index of 156.60. The index is based on the cost of three basic materials, lumber, steel and cement, and the average of common labor wages in twenty cities. The current increase is due to a stiffening in labor rates reported from several cities, enough to raise the index in the face of declining lumber prices. The *ENR* construction volume index for August is 111, as compared with the July index of 166, high for the year.

Steel prospects brighter

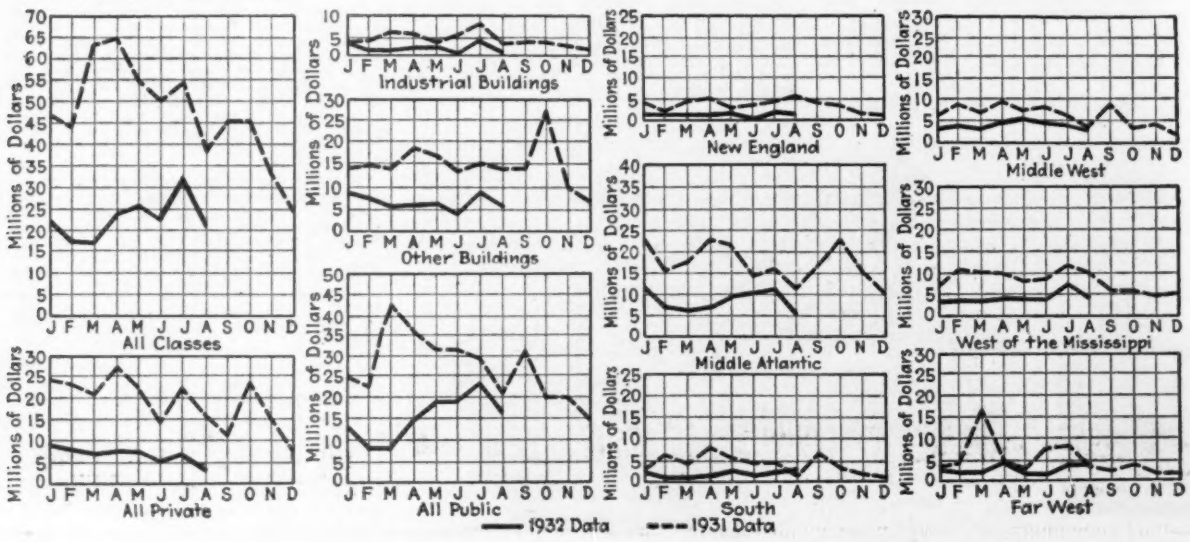
Considerable optimism prevails in the steel trade, though the August production was extremely low. An increase in the demand for steel is expected to start early

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN AUGUST, 1932

Four Weeks—Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States Aug., 1932	United States Eight Months 1931	United States Eight Months 1932	Canada Aug., 1932
Waterworks	105	145	52	54	66	6,106	6,528	41,255	20,832	62
Sewers	370	936	5	166	140	72	1,689	47,529	16,738	117
Bridges, public	256	949	190	1,351	1,803	494	5,043	86,589	36,030	172
Earthwork and waterways	71	555	3,000	1,086	1,350	341	6,403	15,449	58,125	30
Streets and roads	1,674	4,945	5,091	5,041	9,578	3,796	30,125	424,550	219,524	2,785
Unclassified, public	151	37	475	122	45	119	949	59,734	32,771	207
Buildings, public	1,679	5,110	1,874	1,723	4,093	1,251	15,730	167,618	166,453	51
Total public	4,306	12,667	10,687	9,543	17,075	10,479	66,467	1,024,382	550,473	3,424
Federal government (included in above classifications)	894	3,724	4,457	2,154	3,038	2,439	16,706	181,658*	167,771	.....
Buildings, industrial	757	1,299	94	932	407	385	3,874	119,756	67,651	2,030
Buildings, commercial	390	6,332	118	800	225	1,001	8,866	402,217	132,593	1,204
Bridges, private	25	255	.....	50	450	.....	780	8,965	3,404	.....
Earthwork, private	.....	.....	.....	25	.....	.....	25	.....	550	.....
Unclassified, private	110	61	120	1,150	20	161	1,622	232,838	45,536	410
Total private	1,282	7,947	332	2,957	1,102	1,547	15,167	763,776	249,734	3,644
August, 1932 (4 weeks)	**5,588**	**20,624**	**11,019**	**12,500**	**18,177**	**12,726**	**81,634**	.....	.....	**7,068**
July, 1932 (4 weeks)	5,285	44,229	8,670	16,562	29,063	16,649	120,458	.....	.....	5,758
August, 1931 (4 weeks)	20,020	47,854	6,059	16,054	40,800	18,114	148,901	.....	.....	11,182
Eight months, 1932	53,839	286,346	61,225	143,470	152,575	102,752	.....	.....	800,207	38,917
Eight months, 1931	134,727	657,237	177,146	275,427	302,508	241,113	.....	1,788,158	.....	75,858

*Not included in other classifications.



in September and to prevail during the last quarter of the year. The steel trade is looking forward to an order for about 125,000 tons required for the Golden Gate bridge, expected to materialize this fall. Other structural contracts are looked for under provisions of the recently-enacted federal emergency relief act. Latest reports indicate steel ingot production is about 14 per cent of capacity, a figure that has prevailed during the entire month. Hope of increasing production at least 50 per cent in the near future is based on anticipated construction and the present depleted state of jobbers' stocks.

Production of steel ingots as reported by the American Iron & Steel Institute was 792,533 tons for July, as compared with 1,887,580 tons for the corresponding month last year. Production for the first seven months of this year totaled 8,360,302 tons, less than half of the 1931 volume of 17,447,440 tons for the same period.

Despite the low production volume, steel prices have, for the most part, remained firm, with slight increases noted in some lines in July.

Cement price rise spreads

The upward movement in the price of cement noticeable throughout the central West in July spread to several mills in the East and South during August. Advances of 29c. per bbl. were made at mills in Hudson, N. Y., North Birmingham, Ala.; 39c. at Richard City, Tenn., and 19c. at Northampton, Pa. The increase in the Hudson River valley and upstate sections of New York was accompanied by a change in delivery policy. Most mills in these districts have abandoned truck delivery in favor of rail haulage and are now quoting on that basis.

Production of cement in July was reported at exactly one-third of capacity, as compared with a production of 35.7 per cent of capacity in June and 30.2 per cent in May. The cement industry in July produced 7,659,000 bbl., shipped 9,215,000 bbl. from the mills, and had in stock at the end of the month 22,479,000 bbl. Production in July showed a decrease of 44.9 per cent and shipments a decrease of 40.7 per cent as compared with the same month last year. Stocks on hand were 13.3 per cent lower than a year ago.

Slight improvement in lumber

Lumber mills experienced the most favorable flow of new business in several months during the week ended Aug. 20, according to the National Lumber Manufacturers Ass'n. Orders received during the week by all mills, both soft and hardwood, amounted to 32 per cent above production and shipments were 22 per cent over cuttings. Hardwood mills received orders totaling 63 per cent above the cut and shipments amounted to 54 per cent over production. For the first time this year one of the major lumber groups, southern pine, showed a higher percentage of orders received as compared with last year.

Common labor rates improve

The average of common labor rates reported from twenty cities was 43.08c. per hour for August, as compared with 42.2c. and 41.14c. per hour for July and June, respectively. Skilled labor rates showed very little change from the previous month's standings. Following are comments on the labor situation in various centers:

Pittsburgh—A strike on the new $8,000,000 post office, now nearly two months old, is apparently far from settlement. Work was resumed one day two weeks ago, only to stop again the next day because of a renewed walkout by hoisting engineers. The original trouble was caused by the use of non-union engineers on the sand and gravel barges, though the sand company furnishing material is not a member of the local Building Trades Employers Ass'n., which has a working agreement with the unions. The renewed trouble was apparently caused by failure of employers and trades to agree on certain interpretations of the agreement, these interpretations having no direct bearing on the post office job, as the material handling was arranged satisfactory to the unions. A scale of 70c. for union laborers and 90c. for hod carriers was agreed upon by all parties.

Canada—The following agreements have been made with International Unions: Halifax, electrical workers, 85c.; St. John, plumbers, 65c.; Toronto, metal lathers, $1.00, wood lathers, 62½c., stone cutters, $1.00; Ste. Catherines, carpenters, 90c.

Buffalo—Establishment of a 2½-day week for skilled labor instead of the proposed 5-hour day of two shifts was recommended at a meeting of the Board of Supervisors, contractors and union officials.

Cincinnati—A minimum of 45c. per hour is required to be paid on all city contracts.

Montreal—Hand labor methods are being advocated by some city officials. Recent tenders received for a sewer project show hand excavation will cost about $6,000 more than machine excavation, and the city council is now faced with the question of deciding the method to be used in the face of agitated property owners, who will have to bear the extra expense.

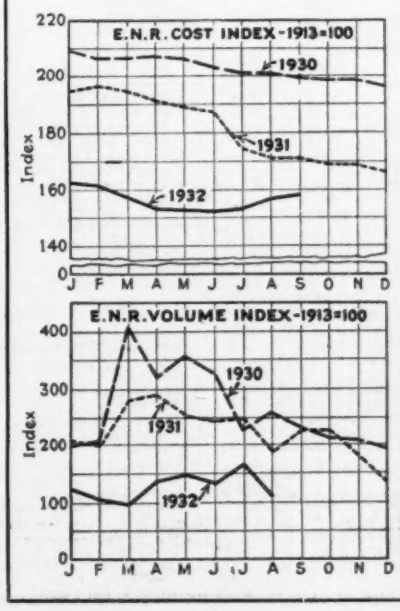
Philadelphia—Unemployment reported on the increase in building trades.

St. Louis—Sflight improvement noticed in common labor employment. Skilled trades still 50 per cent unemployed, with another 20 per cent on part time.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Cities	Bricklayers	Carpenters	Hoisting Engineers	Pile Drivers	Structural Iron Workers	Masons' Laborers	Common Laborers
Atlanta	$0.75@1.12½	$0.40@.90	$0.60@1.25	.....	$0.60@1.25	$0.25	$0.20@.25
Baltimore	.90@1.00	.80@.90	1.00@1.37½	$0.65	1.09@1.25	.40	.30
Birmingham	.75@.87½	.60	.75	.....	.75	.15@.25	.20@.30
Boston	.90@1.30	.80@1.17½	1.00@1.37½	.75@1.07½	1.00@1.37½	.45@.70	.40@.70
Cincinnati	.90@1.27½	.50@1.02½	1.07½	1.07½	1.06½@1.20	.70	.40@.45
Chicago	1.37½	1.31½	1.31½	1.31½	1.35	.82½	.50@.82
Cleveland	.90@1.37½	.87½@1.12½	.90@1.12½	1.00	.90@1.06½	.56½	.30@.72
Dallas	.62½	.50	.50	.50	.50	.25	.25@.35
Denver	1.00@1.12½	.75@.87½	.75@.87½	.....	.75@.87½	.50	.31½@.50
Detroit	1.25@1.50	.80	1.25	1.25	1.25	.70	.30@.50
Kansas City	1.30	1.12½	1.12½	1.06	1.12½	.82½	.45@.50
Los Angeles	.62½	.50	.75	.75	.75	.50	.35@.50
Minneapolis	1.10	.75	.80	.....	.90	.70	.45
New Orleans	.60@.80	.40@.50	.80@1.12½	.90	.80@1.12½	.50	.15@.20
New York	1.50@1.65	1.25@1.40	1.50@1.65	1.50	1.65	.81½@1.00	.50@.75
Philadelphia	1.00@1.25	.60@.90	1.00	.75	1.00	.30@.40	.20@.30
Pittsburgh	.60@1.50	.60@1.25	.60@1.37½	1.00@1.18½	.60@1.37½	.50	.40@.70
St. Louis	1.50	1.25	1.35@1.47	1.25	1.47	1.00	.35@.78½
San Francisco	1.10	.90	.90	1.00	1.00	.62½	.50@.62½
Seattle	.75@1.20	.50@.90	1.00	.90	1.10	.66	.40@.50
Montreal	.75	.60	.55	.....	.70	.45	.25@.30

Construction Cost and Volume Index Numbers



The Cost Index rose from 156.80 in August to 157.96 in September because of an increase in common labor rates in several cities. The Volume Index dropped to 111 for August, the lowest since last March.

E.N.-R. Cost		E.N.-R. Volume	
September, 1932	157.96	August, 1932	111
August, 1932	156.80	July, 1932	166
September, 1931	171.40	August, 1931	187
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 average	100.00		
1931		1931	
January	194.48	January	208
February	196.61	February	198
March	194.51	March	278
April	191.63	April	289
May	189.33	May	251
June	187.23	June	243
July	174.37	July	248
August	171.38	August	187
September	171.40	September	225
October	169.78	October	229
November	169.28	November	180
December	166.23	December	133
1932		1932	
January	162.48	January	121
February	161.82	February	105
March	157.24	March	97
April	153.12	April	135
May	152.78	May	149
June	152.20	June	131
July	153.36	July	166
August	156.80	August	111
September	157.96		

Current Prices of Construction Materials

Building Materials

PORTLAND CEMENT — Prices are for carload lots. For cement in returnable cloth bags add 40c. per bbl.; in non-returnable paper bags add 15c. per bbl., to following net prices:

	F.o.b.	Delivered		F.o.b.	Delivered
Atlanta	$2.30	$2.85	Kansas City	$1.50	$1.60
Baltimore	....	1.77	Los Angeles	2.10	2.10
Birmingham	2.02	2.12	Minneapolis	2.10	2.25
Boston	1.58	1.68	Montreal	1.70	....
Chicago	1.60	1.95	New Orleans	1.86	2.20
Cincinnati	1.52	1.64	New York	1.59	1.70
Cleveland	1.25	1.50	Philadelphia	1.84	1.94
Dallas	2.23	2.38	Pittsburgh	1.68	1.78
Denver	....	2.40	St. Louis	1.64	2.15
Detroit	1.47	1.80	San Francisco	2.05	....
			Seattle	2.55	2.70

Current mill-prices per barrel to dealers, for carloads of 132 barrels or over, without including charge for four bags, f.o.b. Bag charges same as in preceding table:

Alpena, Mich.	$1.20	Mason City, Ia.	$1.35
Buffington, Ind.	1.25	Norfolk, Va.	1.61
Dallas, Tex.	1.75	Northampton, Pa.	1.40
Hannibal, Mo.	1.25	North Birmingham, Ala.	1.60
Hudson, N. Y.	1.50	Richard City, Tenn.	1.70
Independence, Kan.	1.35	Steelton, Minn.	1.45
Ironton, Ohio	1.06	Universal, Pa.	1.21
Iola, Kan.	1.35	Waco, Tex.	1.75
La Salle, Ill.	1.25	Wyandotte, Mich.	1.20
Limedale, Ind.	1.25		

SAND AND GRAVEL — Per ton, carload lots, gravel, size ¾-in.:

	Gravel		Sand	
	F.o.b.	Delivered	F.o.b.	Delivered
Atlanta	$1.95	$2.75	$1.50	$2.50
Baltimore	....	2.55	....	2.08
Birmingham, per cu.yd.	....	3.00	....	2.40
Boston	1.40	1.65	.90	1.15
Chicago, per cu.yd.	....	2.25	....	2.25
Cincinnati	1.30	1.60	1.05	1.35
Cleveland	....	2.00	....	2.00
Dallas, per cu.yd.	1.00	1.50	1.00	1.50
Denver, per cu.yd.	1.75	1.85	1.15	1.20
Detroit	.50	1.45	.72	1.50
Kansas City	.75	....	.60	....
Los Angeles	1.35	1.35	.85	.90
Minneapolis	....	1.60	....	.65
Montreal	1.50	....	1.25	....
New Orleans	1.50	2.50*	1.20	2.00*
New York, per cu.yd.	1.60	3.25	1.00	2.00
Philadelphia	....	1.66	....	1.38
Pittsburgh	....	1.20	....	1.40
St. Louis	1.00	1.40	.80	1.35
San Francisco	1.75	....	1.75	....
Seattle, per cu.yd.	1.75	....	1.75	....

*Cu.yd.

CRUSHED STONE — Per ton, size 1½-in., carload lots, limestone:

	F.o.b.	Delivered
Atlanta	$1.95	$2.75
Baltimore	....	2.60
Birmingham	.80	1.05
Boston	1.40	1.65
Chicago, per cu.yd, 2,500 lb.	....	2.25
Cincinnati	1.65	1.85
Cleveland	....	2.00
Dallas, per cu.yd., 2,500 lb.	1.90	....
Denver, granite, per cu.yd., 2,700 lb.	....	2.50
Detroit	1.09	1.95
Kansas City	1.25	....
Los Angeles	1.35	1.35
Minneapolis	....	1.60
Montreal	1.35	....
New York, per cu.yd., 2,800@3,000 lb.	1.60	3.25
Philadelphia	....	2.00
Pittsburgh	....	2.25
St. Louis	1.35	1.65
San Francisco, trap rock	1.65	....
Seattle, per cu.yd., 3,000 lb.	1.10	....

CRUSHED SLAG—Prices for carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Slag Sand
Birmingham	$0.90	$1.15	$2.05	$0.55
Buffalo	1.35	1.35	2.25	1.25
Cleveland	1.70	1.70	....	1.35
Toledo	1.20	1.20	1.20	1.10
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown	1.10	1.20	2.00	.75

CONCRETE BLOCKS—Standard, 8x8x16-in., hollow, delivered to job, each:

Birmingham (5x8x12)	$0.084	Kansas City	$0.16
Boston	.16	Los Angeles	.15
Brooklyn and Queens	.12	Minneapolis	.09
Chicago	.175	Montreal	.14
Cleveland	.165	New Orleans	.18
Denver	.15	Philadelphia	.15
Detroit	.08	Pittsburgh	.14
		St. Louis	.14

READY MIXED CONCRETE—Per cu.yd., 1:2:4, delivered 50 cu.yd. or more:

Atlanta	$7.75	Los Angeles	$5.40
Birmingham	4.90	Minneapolis	6.00
Boston	7.50	New Orleans	6.20
Cincinnati	7.10	New York (Manhattan)	8.50
Dallas	6.00	Philadelphia	5.98
Detroit 1:2½:5	5.90	Pittsburgh	5.75
Kansas City	7.50	St. Louis	7.00
		Seattle	5.35

HOLLOW TILE—Building tile per block, delivered to contractor in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.09	$0.11	$0.13	$0.20	$0.25
Baltimore	.10*	.14	.20	.22*	.30
Birmingham	.089	.122	.167	.219	.25
Boston	.075	.11	.135	.195	.30
Chicago	.0484	.063	.09	.1179	.13
Cincinnati	.06815	.....	.....	.165	.....
Cleveland	.048	.066	.09	.117	.13
Dallas	.084	.121	.159	.177	.234
Denver	.085	.135	.175	.19	.25
Detroit	.0505	.065	.0947	.1175	.1305
Kansas City	.0755	.092	.15	.17775	.20725
Los Angeles	.09425	.134	.188	.2325	.3115
Minneapolis	.0635	.09395	.1232	.13425	.2103
New Orleans	.085	.115	.16	.225	.255
New York	.075	.1164	.145	.....	.....
Perth Amboy	.....	.....	.....	.2388*	.2956*
Philadelphia	.065	.093	.14	.175	.195
Pittsburgh	.0435	.065	.088	.1165	.126
St. Louis	.067	.098	.12	.16	.20
San Francisco	.0765	.105	.1765	.....	.....
Seattle	.085	.115	.18	.....	.....

*At plant. (Load-bearing tile).

BRICK — Prices per thousand in carload lots, as follows:

	Common Backing		Face		Paving F.o.b.
	F.o.b.	Delivered	F.o.b.	Delivered	3x8½x4-in.
Atlanta	$8.50	$14.00	$15.50	....	$32.00
Baltimore	....	12.00	....	$25@35	43.00†
Birmingham	10.00	12.50	20.50	23.00	27.00
Boston	12.00	16.00	24.00	28.00	43.00
Chicago	....	9.00	....	32.50	32.00
Cincinnati	13.50	16.00	.....	24.00	36.50
Cleveland	12.00	14.00	.....	24.00	33.00
Dallas	....	12.00	....	23@26	25.00
Denver	13.00	....	18@27	....	40.00
Detroit	11.50	12.50	17@30	19@32	25.00
Kansas City	12.00	13.00	.....	26@35	35.00
Los Angeles	8.00	8.50	.....	24.00	....
Minneapolis	....	7.50	....	30.00	....
Montreal	21.25	....	35.00	....	....
New Orleans	10.50	14.50	40.00	45.00	40.00
New York	9.50	11.50	28.00	30.00	45.00
Philadelphia	....	13.00	....	25@30	40.00
Pittsburgh	11.00	13.00	18.00	22.00	25.00
St. Louis	....	12.00	.....	22.00	32.00
San Francisco	14.00	....	.....	.....	45.00*
Seattle	12.00	14.00	.....	.....	48.50

*2½x8½x4-in. †3½x8½x4 in.

LIME — Prices of hydrated, per ton, in paper; lump, per 180-lb. bbl., net:

	Hydrated Finishing		Hydrated Common		Common Lump,	
	F.o.b.	Delivered	F.o.b.	Delivered	F.o.b.	Delivered
Atlanta	$13.50	$18.00	$11.50	$15.50	.....	$2.50
Baltimore	....	20.00	.....	13.00	.....	....
Birmingham	21.00	....	12.00	.....	1.65	....
Boston	17.00	19.00	12.00	14.00	$2.35*	3.25*
Chicago	....	20.00	.....	14.00	.....	2.75
Cincinnati	11.00	12.00	9.40	10.40	.....	....
Cleveland	10.50	14.00	8.50	12.00	.....	2.50
Dallas	....	20.00	.....	.....	.....	2.50
Denver	....	30.00	.....	22.00	.....	2.85*
Detroit	8.90	14.00	7.00	12.00	.....	....
Kansas City	....	22.00	.....	.....	.....	2.75
Los Angeles	24.00	26.00	17.00	18.00	.....	2.00
Minneapolis	.....	21.00	.....	19.00	.....	1.70
Montreal	....	18.00	12.00	13.00	.....	....
New Orleans	14.75	22.50	11.50	14.00	1.66	1.95
New York	10.70	14.00	8.60	12.50	2.25*	3.15*
Philadelphia	11.50	15.39	9.90	13.49	.....	1.18
Pittsburgh	11.50	13.00	10.75	12.25	1.85	2.35
St. Louis	....	.45‡	.....	.40‡	.....	2.15
San Francisco	19.00	19.00	19.00	19.00	.....	1.85
Seattle	....	32.00	.....	24.00	.....	2.80

*Per 280-lb. bbl. (net.) ‡Per sack.

LIMESTONE—Mill blocks, f.o.b. siding, per cu.ft.:
New York: Rustic buff, $1.48; Standard gray, $1.48; Standard buff, $1.58; Selected gray, $1.58; Selected buff, $1.68; Variegated, $1.48.
Boston: Rustic buff, $1.43; Standard, $1.56; Selected buff, $1.70.
Pittsburgh: Rustic buff, $1.56; Standard, $1.28 at quarry; Selected buff, $1.86.
Philadelphia: Sel. buff, $1.65; Sel. gray, $1.55; Standard, $1.55; Standard gray, $1.45; Rustic buff, $1.35.
Atlanta: Standard, $1.26

SLATE—Roofing, f.o.b. quarry, Bangor, Pa., net, per square:

No. 1 Clear	$8.25@$9.50
No. 1 Ribbon	6.75@ 7.50
Medium Clear	7.25@ 8.00

Road and Paving Materials

PAVING STONE — Granite, lots of 50,000 blocks, 4x8x4-in., dressed, f.o.b. city:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Birmingham	76.25 per M.
Boston	90.00 per M.
Chicago, 5 in.	3.80 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	95.00 per M.
Dallas	25.00 per M
Detroit, 5 in.	2.80 per sq.yd.
Kansas City	3.25 per sq.yd.
Minneapolis, 4½ in.	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in.	135.00 per M.
Philadelphia, 4x10x5	115.00 per M.
Pittsburgh	115.00 per M.
St. Louis, 5 in.	2.90 per sq.yd

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING — Prices f.o.b., in carload lots:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.15
Chicago	3½	12	1.90
Kansas City	3½	16	2.50
Minneapolis	3½	16	2.25
Montreal	3½	16	2.63
New York	3½	14	1.90
Philadelphia	3½	16	2.02
St. Louis	3½	16	2.10

CURBING—Per lin.ft., 5x16 in., straight, rough, f.o.b., in carload lots:

Atlanta	$0.41	New York	$0.68
Birmingham	.50	Philadelphia (6x20 dressed)	1.40
Boston	.70	Pittsburgh	.80
Dallas	.60	St. Louis	.70
Detroit	.45		

ASPHALT—Paving asphalt, f.o.b., per ton. Packages are 350-lb. bbl. or 425-lb. drums, in carload lots:

	Packages	Tank-car or -boat
Atlanta	$18.40	$14.40
Baltimore (f.o.b. refinery)	16.00	12.00
Birmingham	.....	11.00
Boston	18.00	14.00
Chicago	22.50	15.50
Cincinnati (f.o.b. refinery)	.....	8.00
Cleveland	18.25	14.50
Dallas	.....	27.00
Denver	27.50	.....
Detroit	16.80	12.43
Kansas City (f.o.b. refinery)	18.00	12.00
Los Angeles (f.o.b. refinery)	18.00	12.00
Maurer, N. J. (Bermudes)	.....	25.00
Maurer, N. J. (Trinidad)	.....	21.00
Minneapolis (f.o.b. Twin Cities)	20.00*	16.30
Montreal (f.o.b. factory)	17.00	13.00
New Orleans (f.o.b. refinery)	16.00	12.00
New York (f.o.b. refinery)	16.00	12.00
Philadelphia	16.00	10.00
Pittsburgh	25.00	16.00
St. Louis (f.o.b. refinery)	14.00	10.00
San Francisco (f.o.b. refinery)	16.00	10.00
Seattle (f.o.b. refinery)	20.00	14.00

* Refinery.

LIQUID ASPHALT — Residual, hot application, f.o.b., in tank cars. 8,000 gal. minimum, per gal.:

Atlanta	$0.06
Birmingham	.06
Boston	.055
Cincinnati	.075
Dallas	.05
Kansas City	.05
Los Angeles	.045
Montreal at (refinery)	.09
New York	.05
Philadelphia	.08
Pittsburgh	.05
St. Louis (at refinery)	.035

EMULSIFIED ASPHALT — For penetration and surface treatment, per gal.:

Boston, applied	$0.12
Cincinnati, f.o.b. refinery	.06
New York, applied	.14
Philadelphia, applied	.13
Pittsburgh f.o.b. refinery	.04@.06
St. Louis, applied	.12
Seattle, f.o.b. refinery	.055@.085

Iron and Steel

	Pittsburgh	Chicago	Birmingham	Cleveland
STRUCTURAL SHAPES AND PLATES, per 100 lb., base, carload lots	$1.60	$1.70	$1.75	$1.78
CONCRETE REINFORCING BARS, ¼ in., billet, per 100 lb., carload lots	1.60	1.65	1.75	1.50
SHEETS, per 100 lb., carload lots:				
Hot-rolled No. 10	1.55	1.65	1.85	.....
Hot-rolled annealed No. 24	2.15	2.30	2.25	.....
Galvanized No. 24	2.80	2.95	3.00	.....
TERNE PLATES, per package, I.C., 8-lb. coating, 20x28 in.	9.50	.....	.....	.....
RIVETS, per 100 lb., ½ in., structural, carload lots	2.25	2.35	2.70	2.25
SHEETPILING, per 100 lb., base, carload lots	1.90	2.05	.....	.....
WIRE NAILS, per 100 lb., base, carload lots	1.95	2.00	2.40	1.95
HEAVY MELTING STEEL SCRAP, No. 1, per gross ton, at consuming point	8.75	6.75	7@7.50	7.00

TRIANGLE MESH—Plain, per 100 sq.ft., 4 in. x 4 in., in carload lots:

Style Number	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
032	22	$0.94	$0.96
049	28	1.19	1.22
068	35	1.45	1.49
093	45	1.87	1.91
126	57	2.31	2.37
153	68	2.75	2.82
180	78	3.16	3.24
245	103	4.17	4.27
287	119	4.82	4.94
33[illegible]	138	5.59	5.73
395	160	6.48	6.64
036P	17	.71	.73
053P	24	1.01	1.03

TRIANGLE MESH—*Continued.*:

Style Number	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
072P	31	1.27	1.30
097P	40	1.64	1.68
049R	24	1.01	1.03
067R	31	1.27	1.30
089R	40	1.64	1.68

WIRE ROPE—Discounts from manufacturers' list prices on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	25 %
Galvanized iron rigging and guy rope (add to list)	71%
Galvanized steel rigging and guy rope	12½%
Plow steel round strand rope	40 %
"Special Steel" and extra strong cast steel, round strand rope	32½%

Discount 5 points less than discount for Eastern territory: California, Colorado, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Texas, Washington and Wyoming. Discount 10 points less than discount for Eastern territory: Arizona, Idaho, Montana and Utah.

EXPANDED METAL LATH—Per 100 sq.yd., painted, f.o.b., in carload lots 2.2 lb. per sq.yd., standard-mesh diamond lath:

Atlanta	$20.00*	Los Angeles	$17.00
Birmingham	17.00	New Orleans	20.50
Boston	15.00	New York	13.50
Chicago	10.60	Philadelphia	13.50
Cincinnati	11.00	Pittsburgh	13.50
Dallas	16.50	St. Louis	19.00*
Detroit	18.00*	San Francisco	17.00*
Kansas City	17.00	Seattle	19.00

*Delivered.

STEEL FREIGHT RATES — Per 100 lb., effective Dec. 3, 1931, on finished steel products in the Pittsburgh District, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc.; 40,000 lb. per car:

Atlanta, 36,000 lb.	$0.60	Detroit	$0.285
Baltimore	.29	Kansas City	.59
Birmingham	.60	New Orleans, 36,000 lb.	.69
Boston	.42	New York, 36,000 lb.	.35
Buffalo	.255	Pacific Coast, 60,000 lb.	1.17*
Chicago	.36	Philadelphia	.31
Cincinnati	.285	St. Louis	.41
Cleveland	.205	St. Paul	.60
Denver	.92	* All rail.	

Railway Materials and Supplies

STEEL RAILS—Standard rails have been $43.00 per gross ton since Sept., 1922, at which time the price was $40.00; other rails, per gross ton, f.o.b., as follows:

	Pittsburgh	Birmingham	Chicago
Light rails	$32.00	$32.00	$34.00
Re-rolled rails	23.00	.....	27.00

RAILWAY TIES — Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.00	.....
	Pine, untreated	.90	.....
	Pine, creosoted	1.40	.....
New York	Long-leaf sap pine, untreated	.90	$1.10
	Dense yellow pine, untreated	.65	.85
Birmingham	White oak, untreated	.90	1.05
	White oak, creosoted	1.45	1.55
	Southern pine, untreated	.45	.90
	Southern pine, creosoted	1.05	1.40
Chicago	White oak, untreated	1.05	1.35
	Oak, empty cell, creosoted	1.40	1.80
	Oak, zinc treated	1.25	1.65
	Southern pine, creosoted	1.15	1.50
Los Angeles	Fir, untreated	.47	.....
	Fir, creosoted	1.20	.....
Philadelphia	Red oak, untreated	.95	1.15
	Red oak, creosoted	1.47	1.90
St. Louis	White oak, untreated	.75	1.25
	Red oak, untreated	.70	1.05
	Red oak, creosoted	105	1.70
	Sap pine or cypress, untreated	.60	1.00
San Francisco	Douglas fir green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

TRACK SUPPLIES — Prices per 100 lb., f.o.b., for carload lots:

	Pittsburgh	Birmingham	Chicago
Angle bars	$2.75	$2.75	$2.75
Standard spikes	2.60	2.60	2.60
Tie plates	1.85	1.85	1.85
Track bolts	3.50	3.50	3.50

Pipe

WROUGHT STEEL PIPE — Discounts from standard list for delivery from warehouse, except at Pittsburgh, where prices are f.o.b. mill. List prices per ft. as follows: 1-in., 17c.; 3-in., 76½c.; 3½-in., 92c.; 6-in., $1.92.

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Atlanta	44%	36.5%	42%	34%
Boston	55.3%	42.25%	51.35%	40.1%
Chicago	57.25%	44.71%	53.83%	41.29%
Cleveland	53.3%	42.3%	50.8%	37.8%
Denver	44.5%	32%	41%	28.5%
New York	56.14%	43.6%	52.72%	40.18%
Philadelphia	58%	47%	55%	44%
Pittsburgh	64%	52.3%	61%	49.3%
St. Louis	51%	38%	48%	35%

Current Prices of Construction Materials

Pipe—Continued

CAST-IRON PIPE — Prices per net ton, for bell and spigot pipe, Class B and heavier, f.o.b. in carload lots; gas pipe and Class A, $3.00 per ton extra:

	4-In.	6-In. and Over
Atlanta	.....	$42.00
Boston	$37.00	34.00
Birmingham (Base)	32.00	29.00
Burlington (Base)	32.00	29.00
Chicago	37.40	33.40
Dallas	47.50	46.00
Los Angeles	39.00	36.00
New York	30.20	27.50
Philadelphia	30.00	27.00
Pittsburgh	38.50	35.50
St. Louis	43.00	40.00
San Francisco	48.00	45.00

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.125	$0.21	$0.385	.....	$1.40	.....	.....
Baltimore	.10	.30	.58	.....	1.93	.....	$6.50
Birmingham	.18	.30	.54	$1.02	1.95	$3.50	5.00
Boston	.16	.25	.50	1.25	2.10	4.40	5.50
Chicago	.18	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.108	.21	.324	1.05	1.755	3.528	5.4325
Cleveland	.135	.21	.405	1.125	2.025	4.824	7.38
Dallas	.23	.325	.586	1.106	1.95	3.68	5.00
Denver	.16	.23	.414	.816	1.44	.....	.....
Detroit	.0855	.....	.2625	.....	1.90	3.80	.....
Kansas City	.21	.335	.52	1.00	1.90	3.80	.....
Los Angeles(f.o.b.)	.2175	.2825	.5085	1.1865	2.034	3.69	.....
Minneapolis	.18	.23	.46	1.20	1.85	3.20	4.26
Montreal	.30	.45	.75	1.95	2.60	.....	7.20
New Orleans	.18	.30	.54	1.02	1.95	.....	.....
New York	.13	.21	.42	1.15	2.10	.....	.....
Philadelphia	.081	.126	.243	.65	1.17	2.376	4.615
Pittsburgh	.09	.18	.27	.62	1.22	2.45	3.68
St. Louis	.1295	.210	.378	.945	1.62	3.20	4.40
San Francisco	.175	.25	.45	1.05	1.80	3.00	4.50
Seattle	.22	.30	.54	1.26	2.16	2.50	5.50

CLAY DRAIN TILE—Per 1,000 lin.ft., f.o.b., in carload lots, 4 in.:

Atlanta	$50.00	Los Angeles	$60.00
Birmingham	50.00	New Orleans	40.00
Boston	43.00	New York	35.00
Chicago	40.00	Philadelphia	36.00
Dallas	65.00	Pittsburgh	80.00
Denver	75.00	St. Louis	40.00
Detroit	40.00	San Francisco	67.50
Kansas City	70.00	Seattle	60.00

Miscellaneous

LINSEED OIL—Raw, in 4-bbl. lots, per lb., f.o.b.:

Atlanta	$0.07	Minneapolis	$0.064
Birmingham	.066	Montreal (per gal.)	.54
Boston (per gal.)	.50	New York	.064
Dallas	.073	Philadelphia	.059
Denver	.0893	Seattle	.075
Kansas City (per gal.)	.51	St Louis	.068
Los Angeles	.0813	San Francisco (del)	.1125

WHITE LEAD—In oil, per 100 lb. keg., f.o.b.:

Atlanta	$12.50	Los Angeles	$11.50
Birmingham	12.50	New Orleans	11.00
Boston	11.50	New York	12.00
Dallas	13.00	Philadelphia	9.50
Kansas City	12.13	Seattle	11.00
		St. Louis	12.00

Note: Both white and red lead, dry, same prices as foregoing; red in oil, $1.50 higher

CHEMICALS—Water, sewage treatment, road work, f.o.b., carlots, New York:

Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.75
Calcium chloride, 77-80%, flaked, in 400-lb. drums, f.o.b. works, per ton	21.00
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in bags, per 100 lb.	1.17½
Sulphate of aluminum, in bags, per 100 lb	1.25
Sulphate of copper, in bbl., per 100 lb.	2.75

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¾-in., 6-ft., 1-in.; ¾-in., 4-ft., 5-in.; 1-in., 3-ft., 8-in.; 1¼-in., 2-ft., 5-in.; 1½-in., 1-ft., 8-in. Following prices are per lb. for ¾-in. and larger, delivered in 1,200 ft. coils:

Atlanta	$0.16	Kansas City	$0.21
Baltimore	.225	Los Angeles	.1725
Birmingham	.20	Minneapolis	.175
Boston	.16	Montreal	.1625
Chicago	.175	New Orleans	.165
Cincinnati (f.o.b.)	.21	New York	.165
Cleveland	.21	Philadelphia	.15
Dallas	.25	St. Louis	.155
Denver	.184	San Francisco	.175
Detroit	.185	Seattle	.175

BUILDING PAPER—Black, 50-lb. per roll of 500 sq.ft., in carloads, f.o.b., producing point $2.00

SLATERS FELT—In carloads, per roll, f.o.b., producing point $0.60

PREPARED ROOFING—Per square, f.o.b., in carload lots:

	Single Shingles*	Strip Shingles†	Rolls‡
Atlanta	$5.85	$6.25	$2.05
Boston	6.75	6.50	2.65
Dallas	5.25	4.50	2.25
Detroit	.....	.....	2.00
Montreal	6.40	6.20	2.68
New Orleans	5.60	5.50	2.00
New York	6.50	6.25	2.50
Philadelphia	5.85	5.00	1.85
Seattle	.....	6.60	2.55
St. Louis	3.80	3.65	1.40

*Slate finish, sufficient to cover 100 sq.ft. ‡Slate surfaced, in rolls weighing 85 to 90 lb. †4 in 1, hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—In carload lots, f.o.b.:

	Asphalt Felt, per 100 Lb.	Tar Felt, per 100 Lb.	Asphalt Coating, per Gal.	Tar Pitch,* per Ton
Atlanta	$44.50†	$44.50†	$0.45	$44.50
Boston	2.50	2.50	0.35	30.00
Dallas	3.25	3.50	1.00	42.00
Denver	2.00	2.00	.90	18.00
Montreal	2.62‡	2.02‡	1.40	1.63
New Orleans	.....	2.50	.....	22.50
New York	2.40	2.40	.34½	28.00
Philadelphia	2.25	2.25	.35	22.00
Seattle	2.40	2.40	.55	27.90

*In 350 lb. barrels. †Per ton. ‡Per roll.

WINDOW GLASS—Discounts from latest jobbers list, dated Sept. 15, 1928, for sizes above first three brackets:

	Single Thickness		Double Thickness	
	A Quality	B Quality	A Quality	B Quality
Atlanta	85%	85%	85%	85%
Birmingham	89%	91%	89%	91%
Boston	87%	89%	87%	89%
Dallas	85%	87.5%	87.5%	89.5%
Denver	84@5%	86@5%	84@5%	86@5%
Kansas City	90@5%	90@5%	90@5%	90@5%
New York	87%	89%	87%	89%
Philadelphia	88%	90%	88%	90%
Pittsburgh	87%	89%	87%	89%
Seattle	90@10%	90@20%	90@10%	90@20%

EXPLOSIVES—Price per pound for dynamite delivered:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.215	$0.2375	Los Angeles	$0.1725	$0.1925
Baltimore	.21	.225	Minneapolis	.18	.195
Birmingham	.13	.1525	Montreal	.1675	.1925
Boston	.225	.25	New Orleans	.195	.22
Chicago	.17	.195	New York	.245	.2675
Cincinnati (f.o.b.)	.22	.245	Philadelphia	.215	.24
Dallas	.28	.30	St. Louis	.1975	.2175
Denver	.19*	.21*	San Francisco	.1575	.1825
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

*F.o.b Louviers.

Lumber

LUMBER—Per M. ft., b.m., No. 1, Common, rough, in carload lots:

PINE

	1 x 6 In.* F.o.b.	1 x 6 In.* Del.	1 x 8 In.* F.o.b.	1 x 8 In.* Del.	3 x 12 In.† F.o.b.	3 x 12 In.† Del.	12 x 12 In.† F.o.b.
Atlanta	$14.00	.....	$15.00	.....	$35.00	.....	$45.00
Baltimore	.....	$46.00	.....	.....	.....	$70.00	.....
Birmingham	.....	15.00	.....	$15.00	.....	18.00	25.00
Boston	30.00	35.00	32.00	37.00	40.00	45.00	73.00
Chicago	.....	.....	.....	.....	.....	62.50	.....
Cincinnati	.....	28.00	.....	28.00	.....	35.00	35.00
Cleveland	30.00	38.00	32.00	40.00	46.00	54.00	.....
Dallas	.....	32.50	.....	32.50	.....	47.50	55.00
Denver	.....	31.00	.....	33.00	.....	45.00	.....
Detroit	29.00	29.00	30.00	30.00	32.00	32.00	.....
Kansas City	22.00	.....	23.00	.....	45.00	.....	.....
Minneapolis	.....	31.00	.....	31.00	.....	34.00	.....
Montreal	45.00	.....	52.00	.....	67.00	.....	.....
New Orleans	.....	15.50	.....	16.50	.....	52.00	.....
New York	22.50	23.50	23.50	24.50	47.50	49.50	47.50
Phil. (No. 2 com.)	18.00	22.00	19.00	23.00	29.00	33.00	68.00
Pittsburgh	20.00	33.00	20.00	33.00	32.00	39.00	46.00
St. Louis	22.00	27.00	23.50	28.50	47.00	52.00	45.00

FIR

	1 x 6 In.* F.o.b.	1 x 6 In.* Del.	1 x 8 In.* F.o.b.	1 x 8 In.* Del.	3 x 12 In.† F.o.b.	3 x 12 In.† Del.	12 x 12 In.† F.o.b
Baltimore	.....	.....	.....	.....	.....	$46.00	.....
Boston	$28.00	$33.00	$30.00	$35.00	$33.00	38.00	$53.00
Chicago	.....	.....	.....	.....	.....	44.52	.....
Cincinnati	.....	.....	.....	.....	.....	42.50	42.50
Cleveland	30.00	38.00	32.00	40.00	46.00	54.00	.....
Dallas	30.00	.....	29.00	.....	38.00	.....	36.75
Denver	.....	34.00	.....	36.00	.....	47.00	.....
Detroit	.....	.....	.....	.....	30.00	30.00	.....
Kansas City	30.00	.....	32.00	.....	33.50	.....	.....
Los Angeles	39.00	41.50	39.00	41.50	43.00	45.50	40.00
Minneapolis	.....	31.00	.....	31.00	36.00	36.00	.....
New Orleans	.....	20.00	.....	20.00	.....	42.50	.....
New York	21.50	22.50	22.50	23.50	25.50	26.50	26.50
Philadelphia	.....	.....	.....	.....	.....	28.00	30.00
Pittsburgh	.....	.....	.....	.....	58.00	63.00	48.00
St. Louis	30.00	35.00	30.00	35.00	33.00	38.00	33.00
San Francisco	.....	.....	.....	30.00	.....	32.00	.....
Seattle	10.00	11.00	10.00	11.00	14.00	15.00	.....

*Form lumber, 16 ft. lengths. †Planks and timbers, 20 ft. lengths.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C., per linear foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.09	$0.145
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.13	.195
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.15	.215
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.185	.225
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2025	.225
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.265	.375
14 in.—2 ft. from butt	5 in.	85 to 89 ft	.305	.442